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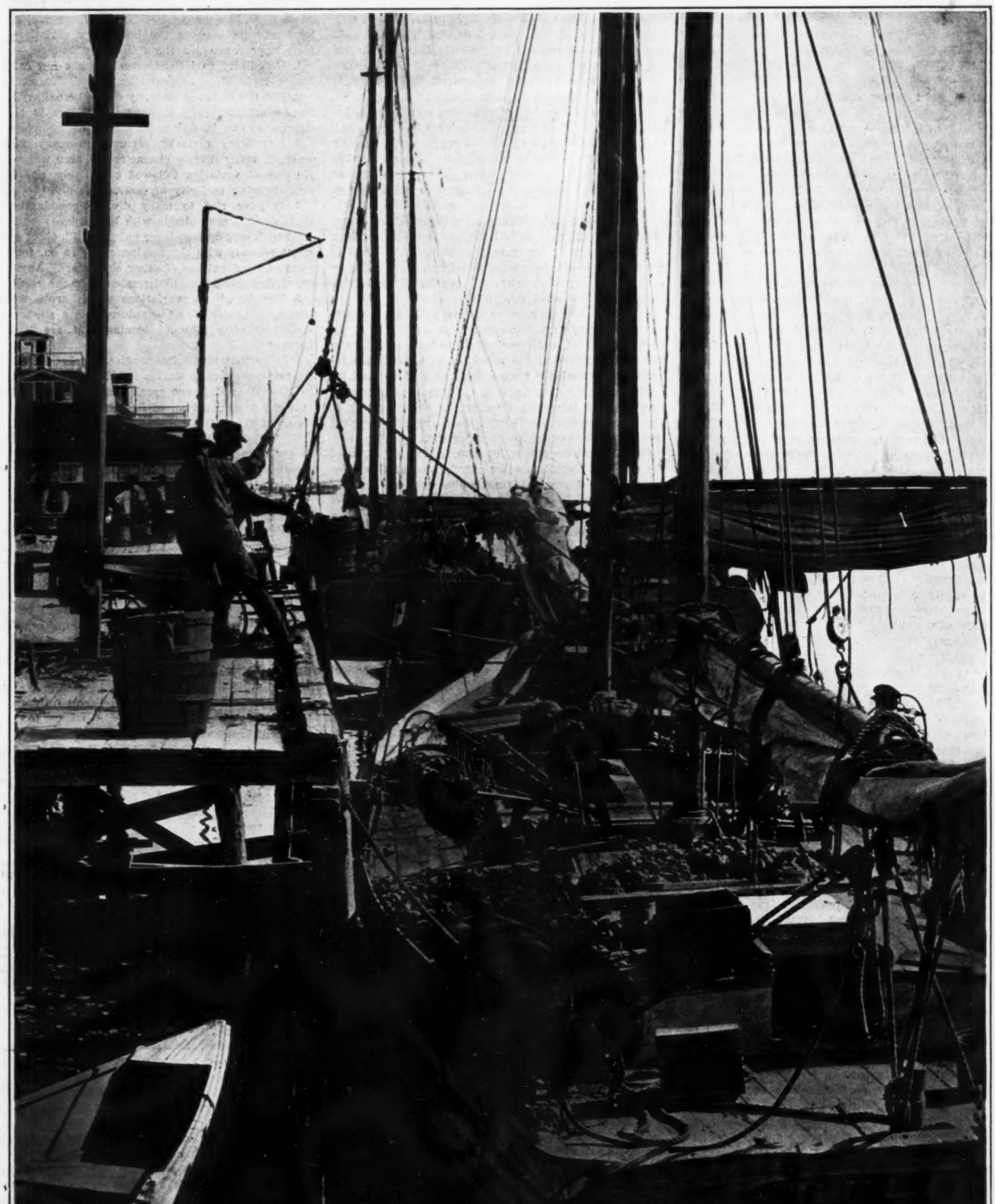


Unloading oysters at Biloxi, Miss.

OYSTERS—A FOOD THAT HAS NOT GONE UP [See page 184]

The Problem of the Method of Evolution—I*

Observed Changes in Hereditary Characters in Relation to Evolution

By H. S. Jennings, Johns Hopkins University

The problem of the method of evolution is one which the biologist finds it impossible to leave alone, although the longer he works at it, the farther its solution fades into the distance. The central point in the problem is the appearance, nature and origin of the heritable variations that arise in organisms; the changes that occur in the hereditary constitution. I have for a long time been studying the appearance of heritable variations in certain lower organisms. Having satisfied myself as to the nature of the variations that arise in the creatures that I have studied, I have looked about to see what other workers have found; and to determine whether any unified picture of the matter can be made. Can we bring these facts which experimental work has brought out into relation with the method of evolution? Can we say that they exclude any particular theory? Can we say that they leave certain views admissible? Can we go farther and say that they make certain views probable? I shall hardly be so bold as even to ask whether they establish any particular views, though even that has been at times affirmed.

These questions have, of course, been raised thousands of times; it is only because knowledge does advance, because experimental work has been enormously multiplied of late, that there is reason to bring them up anew. I am going to try to put before you the present situation as it appears to me.

What we may call the first phase of the modern experimental study of variation is that which culminated in the establishment of the fact that most of the heritable differences observed between closely related organisms—between the members of a given species, for example—are not *variations* in the sense of alterations; are not active *changes* in constitution, but are permanent diversities; they are static, not dynamic. This discovery, like that of Mendelian heredity, was, as you know, made long ago by the Frenchman Jordan; but, as in the case of Mendelism, science ignored it and pursued cheerfully its false path till the facts were rediscovered in recent years. All thorough work has led directly to this result: that any species or kind of organism is made up of a very great number of diverse stocks, differing from each other in minute particulars, but the diversities inherited from generation to generation. This result has in recent years dominated all work on the occurrence of variations; on the effects of selection; on the method of evolution. The condition is particularly striking in organisms reproducing from a single parent, so that there is no mixing of stocks; I found it in a high degree in organisms of this sort which I studied. Thus the infusorian Paramecium I found to consist of a large number of such heritably diverse stocks, each stock showing within itself many variations that are not heritable.[1] *Difflugia corona*, which I have recently been studying, shows the same condition in a marked degree.[2] As you know, a host of workers have found similar conditions in all sorts of organisms. It led to the idea of the genotype (Johannsen), as the permanent germinal constitution of any given individual; it supported powerfully the conception of Mendelism as merely the working out of recombinations of mosaic-like parts of these permanent genotypes. The whole conception is in its essential nature static; alteration does not fit into the scheme.

This discovery seemed to explain fully all the observed effects of selection within a species; but gave them a significance quite the reverse of what they had been supposed to have. It seemed to account for practically all the supposed variations that had been observed; they were not variations at all, in the sense of steps in evolution; they were mere instances of the static condition of diversity that everywhere prevails. Jordan, the devout original discoverer of this condition of affairs, maintained that it showed that organisms do not really vary; that there is no such process as evolution: and indeed this seems to be the direct logical conclusion to be drawn. In these days of plots and spies, the evolutionists might almost feel that the enemy had crept into their citadel and was blowing it up from within.

Now, this multiplicity of diverse stocks really represents the actual condition of affairs, *so far as it goes*. Persons who are interested in maintaining that evolution *is* occurring, that selection *is* effective, and the like, make a very great mistake in denying the existence of the condition of diversity portrayed by the genotypists. What they must do is to accept that condition as a foundation, then show that it is not final; that it does not proceed to the end; that the diverse existing stocks, while heritably different as the genotypists maintain, may also change and differentiate, in ways not yet detected by their discoverers.

But of course most of the adherents of the "orthodox genotype theory" do not maintain, with their first representative Jordan, that no changes occur; that all is genetically static in organisms. Typically, they admit that *mutations* occur; that the genotype may at rare intervals transform, as a given chemical compound may transform into another and diverse compound. We all know the typical instances: the transforming mutations of Oenothera; the bud variations that show in a sudden change of color or form in plants; the dropping out of definite Mendelian units in Drosophila and elsewhere; the transformation of particular Mendelian units into some other condition.

So much then may serve as an outline of a prevailing theory; organisms forming a multitude of diverse strains with diverse genotypes; the genotype a mosaic of parts that are recombined in Mendelian inheritance; selection a mere process of isolating and recombining what already exists; large changes occurring at rare intervals, through the dropping out of bits of the mosaic, or through their complete chemical transformation; evolution by saltations.

Certain serious difficulties appear in this view of the matter; I shall mention merely two of them, for their practical results. One is the very existence of the minutely differing strains, which forms one of the main foundations for the genotype theory. How have these arisen? Not by large steps, not by saltations, for the differences between the strains go down to the very limits of detectibility. On the saltation theory, Jordan's view that these things were created separate at the beginning seems the only solution.

Secondly, to many minds there appears to be an equally great difficulty in the origin by saltation of complex adaptive structures, such as the eye. I shall not analyze this difficulty, but merely point to it and to the first one mentioned, as having had the practical effect of keeping many investigators persistently at work looking for something besides saltations as a basis for evolution; looking for hereditary changes that would permit a continuity in transformation. Some have been searching in the complex phenomena of biparental inheritance; here Castle is to be first named, and in a later lecture you will hear of the views to which he has been led. Others, like Prof. H. F. Osborn, have been searching from this point of view the paleontological records. Others of us have taken up the problem in uniparental reproduction; it is here that my own work falls, and of this I will for a moment speak.

Where reproduction is from a single parent we meet the problem of inheritance and variation in its simplest form; for there is nothing which complicates genetic problems so enormously as does the continual mixing of diverse stocks in biparental inheritance. In uniparental reproduction we have but one genotype to deal with; we can be certain that no hereditary characters are introduced from outside that genotype.

To hope for results on the problem in which we are interested, we must resolve to carry on a sort of second degree research, as it were. That is, we must accept as a foundation the facts before discovered, as to the make-up of the species out of a great number of diverse stocks; as to the usual effects of selection being nothing save the isolation of such preexisting stocks. What we must do is to take a single such stock—choosing an organism that is most favorable for such work—then proceed to a most extensive and intensive study of heredity, of variation, and of the effects of selection for long periods within such a stock.

Such an organism, most favorable from all points of view, I found in the rhizopod *Difflugia corona*. It has numerous distinctive characters, all congenital; all inherited in a high degree; yet varying from parent to offspring also; none of these characters changed by growth or environmental action during the life of the individual.

Long continued work showed that a single strain of this animal, all derived by fission from a single parent, does differentiate gradually, with the passage of generations, into many hereditarily diverse strains. The important facts about the hereditary variations and their appearance are the following:

1. Hereditary variations arose in some few cases by rather large steps or "saltations."

2. But the immense majority of the hereditary variations were minute gradations. Variation is as continuous as can be detected.

3. Hereditary variation occurred in many different ways, in many diverse characters. There was no single line of variation followed exclusively, nor in the overwhelming majority of cases.

4. It gave rise to many diverse combinations of characters: large animals with long spines; small animals with long spines; large animals with short spines; small animals with short spines; and so on, for other sorts of combinations of other characters. Any set of characters might vary independently of the rest.

5. The hereditary variations which arose were of just such a nature as to produce from a single strain the hereditarily different strains that are found in nature.[3]

I judge that if the intermediate strains were killed, the two most diverse strains found in nature might well be classed as different species, although the question of what a species is must be left to the judgment or fancy of the individual.

Such then were the results of my own studies as to the nature of hereditary variations and how they appear. How do these results compare with those found by other men? If we take a general survey, we find the following main classes of cases:

1. First, we have the mutations of Oenothera and its relatives: large transformations occurring suddenly. Here is evidently one of the most interesting fields of genetics, but I cannot feel, in view of many extraordinary phenomena in this group, that the bearing on the main problems of genetics is yet clear.

2. Second, we have a large miscellaneous collection of mutations observed in various classes of organisms: "bud variations," dropping out of unit factors, and the like—all definite saltations, but not genetically fully analyzed.

3. In Drosophila, as studied by Morgan and his associates, we have the largest and most fully analyzed body of facts which we possess with respect to changes in hereditary character in any organism. The changes here are pictured as typical saltations; but of these I shall speak further.

4. In paleontology, as the results are presented in recent papers by Osborn,[4] the evidence is for evolution by minute, continuous variations which follow a single definite trend.

5. Finally we have the work in biparental inheritance from Castle and his associates:[5] this, as interpreted by Castle, gives evidence for continuous variation, not following a single necessary trend, but guided by external selection.

Furthermore, we discover in our survey that there are at least two well-marked controversies in flame at the present time:

First, we have the general controversy between, on the one hand, those who are mutationists and adherents of the strict genotype view; on the other hand, those who, like Castle, believe that we observe continuous hereditary variations in the progress of biparental reproduction. The mutationists attempt to show that the apparent gradual modification of characters observed in breeding is in reality a mere working out of Mendelian recombination. Here we have contributions by Morgan (1916), Pearl (1916, 1917), MacDowell (1916), Hagedorn (1914) and others on the one hand; while the full brunt of the attack is borne on the other side by Castle.

Second, we have a somewhat less lively controversy between the genotypic mutationists and the paleontological upholders of evolution by continuous variation.

*A lecture delivered before the Washington Academy of Sciences and reproduced from the *Journal of the Academy*.

[1] See Jennings, 1908, 1909, 1910, 1911. (See Bibliography.)

[2] Jennings, 1916. (See Bibliography.)

[3] The full account of this work is given in Jennings, 1916. (See Bibliography.)

[4] See Osborne, 1912, 1915, 1916. See Bibliography.)

[5] See Castle, 1915a, 1916, 1916a, 1916b, 1917; Castle and Phillips, 1914, etc. (See Bibliography.)

Echoes of this we find in recent publications by Osborn and by Morgan.

Now let us look briefly into the points at issue in the controversy between the "genotypic mutationists" and the upholders of gradual change during biparental inheritance.

Castle finds that in rats he can, by selection, gradually increase or decrease the amount of color in the coat, passing by continuous stages from one extreme to the other. As to this, he holds two main points:

1. The change is an actual change in the hereditary characteristics of the stock; not a mere result of the recombination of Mendelian factors. This is the general fundamental point at issue.

2. More specifically, he holds it to be an actual change in a single unit factor; this single factor changes its grade in a continuous and quantitative manner.

On the other side, the critics of these views maintain that the changes shown are not actual alterations in the hereditary constitution at all, but are mere results of the recombinations of Mendelian factors. And specifically, they find a complete explanation of such results as those of Castle in the hypothesis of *multiple modifying factors*.

The methods in which these modifying factors are conceived to operate is doubtless familiar to you: their application to Castle's work with selection in rats will serve as an example. There is conceived to be a single "main factor" which determines whether the "hooded pattern" shall or shall not be present. In addition to this there are a considerable number of "modifying factors" which, when the "hooded pattern" is present, increase or decrease the extent of pigmentation. When many of the positive factors of this sort are present, the rat's coat has much pigment; when fewer are present the extent of pigment is less, and so on. The process of changing the extent of pigmentation by selection consists, according to this view, merely in making diverse combinations of these factors, by proper crosses.

This same explanation is applied to a great variety of cases. Castle had carried the war into the enemy's country by predicting (or at least suggesting) that the so-called unit characters in Drosophila would be found to be modifiable through selection.[6] Later research by MacDowell (1915), Zeleny and Mattoon (1915), Reeves (1916), Morgan (1917), and Sturtevant (1917) actually verified this prediction; it has indeed been found that the Drosophila mutations can be modified by selection. Again the mutationists counter the blow with their explanation of multiple modifying factors, which are segregated in the process of selection; and they give some real evidence that such is actually the case.

Now, into the merits of that particular question, as to whether the apparent effects of selection are really due to modifying factors in the manner set forth, I do not propose to enter. Castle maintains that they are not, and I doubt not that he will show you reason for that point of view. At this point my own discussion will diverge from what I judge that he will be likely to give. What I am going to do is to abandon the ground that Castle would defend, proceed directly into the territory of the enemy, accept the conditions met there, then see where we come out in relation to the nature of variation, the effects of selection, and the method of evolution.

In no other organism have heritable variations been studied so thoroughly as in Drosophila, and no other body of men have been more thoroughgoing upholders of mutationism and of the multiple factor explanation of the effects of selection, than the students of Drosophila—Morgan, Sturtevant, Bridges, Dexter, Muller, MacDowell, and the others. We may therefore turn to the evidence from Drosophila with confidence that it will be presented with fairness to the mutationist point of view. We shall first ask (1) what we learn from the work on Drosophila as to the possibility of finding finely graded variations in a single unit character. Next we shall inquire (2) as to the relation of the assumed modifying factors to changes in hereditary constitution; to the nature of the effects of selection.

1. First, then, what are the facts as to numerous finely graded variations in a single unit factor? Here we have certain remarkable data as to the eye-color of Drosophila; data that are of great interest with relation to the nature of evolutionary change. This fruit fly has normally a red eye. Some years ago a variation occurred by which the eye lost its color, becoming white, a typical mutation. Somewhat later, another variation came, by which the eye color became eosin. By those wonderfully ingenious methods which the advance state of knowledge of the genetics of Drosophila have made possible, it was determined that the mutations white and eosin are due to changes in a particular part of a particular chromosome, namely, of the so-called X-chromosome, or chromosome I. And further, it was discovered that the two colors are due to different conditions of the same *locus* of the chromosome; in other words, they represent two different variations of the same unit. Moreover, the normal red color represents a third condition of that same unit.

[6]See Castle, 1915, p. 39. (See Bibliography.)

Somewhat later a fourth condition of this same unit was found, giving a color which lies nearer the red, between the red and eosin; this new color was called cherry. So we have four grades or conditions of this single unit character.

And now, with the minute attention paid to the distinction of these grades of eye color, new grades begin to come fast. In the November number of *Genetics*, Hyde (1916), adds two new grades, one called "blood," near the extreme red end of the series, the other, called "tinged," near the extreme white end; in fact, from the descriptions it requires careful examination to distinguish these two from red and white, respectively. Thus we have now six grades of this unit. And in the same number of the same journal, Safir (1916) adds another intermediate grade, lying between "tinged" and eosin; this he calls "buff." All these seven grades are diverse conditions of the single unit factor, having its locus in a certain definite spot in the X-chromosome. Such diverse conditions of a single factor are known as multiple allelomorphs.

So, up to date we know from the mutationists' own studies of Drosophila that a single unit factor presents seven gradations of color between white and red, each gradation heritable in the usual Mendelian manner. These grades are the following: (1) Red; (2) blood; (3) cherry; (4) eosin; (5) buff; (6) tinged; (7) white.

Three of these grades have been discovered in the last five months. It would not require a bold prophet to predict that as the years pass we shall come to know more of these gradations, till all detectible differences of shade have been distinguished, and each shown to be inherited as a Mendelian unit. Considering that the work on Drosophila has been going on only about seven or eight years, this is remarkable progress toward a demonstration that a single unit factor can present as many grades as can be distinguished; that the grades may give a pragmatically continuous series. The extreme selectionist asks only a little more than this.

Besides showing that a unit factor may thus exist in numerous minutely differing grades, this case shows that a heritable variation may occur so small as to be barely detectible. Although the variations do not usually occur in this way, the case presents the conditions which would allow of a gradual transition from one extreme to the other, by means of numerous intermediate conditions. In a population in which were occurring such minute changes as are here shown to be possible, we could get by selection such a continuous series of gradations as Castle describes in his rats. The difference in the two cases is, that in Drosophila variations which are large steps occur as well as do the small ones; and that, according to Castle's conception of the matter, such minute heritable variations occur more frequently in the rat than in Drosophila. But on the showing of the students of Drosophila, there is scarcely any other difference in principle between what happens in Drosophila and what Castle believes to happen in the rat.

2. But as we have seen, the mutationists reject the view that the changes in the coat color of the rat are due to alterations in a single unit factor; they explain this and other cases of the effectiveness of selection on a single character by *multiple modifying factors*. Accepting again their contention, the question is shifted to the nature of such factors. What sort of things are these modifying factors? What is their relation to actual changes in the heritable constitution of organisms?

Our direct experimental knowledge of these "modifying factors" is scanty. What we have comes again mainly from the studies of Drosophila, so that we need not suspect it of being colored in such a way as to favor the selectionist point of view. We find data as to certain known modifying factors by one of the workers on Drosophila, Bridges (1916), in his recent important paper on non-disjunction of the chromosomes. And here we are taken back again to the series of eye colors, and indeed to one particular member of the series, the middle member, called eosin.[7] Bridges tells us that he found a factor whose only effect was to lighten the eosin color in a fly with eosin eyes; this factor indeed nearly or quite turns the eosin eye white. This factor Bridges calls "whiting." Another factor has the effect of lightening the eosin color a little less, giving a sort of cream color; this is called "cream *b*." A third factor dilutes the eosin color not so much; it is called "cream *a*." In addition to these, Bridges tells us that he has discovered *three other* diluters of the eosin color; we will call them the fourth, fifth, and sixth diluters. And finally Bridges tells us of another factor whose only effect is to modify eosin in the direction of a darker color; this factor he calls "dark." None of these factors has any effect save on eosin-eyed flies.

As you see, these things add tremendously to our gradations in eye color. We had already been furnished seven grades, from white to red; now we have seven secondary grades within a single one of these seven primary grades. Our list of gradations of eye color in Drosophila therefore takes now the following form:

Heritable grades of eye color, due to diverse variations of a single unit located in Chromosome I.	Variations that give modifications of the intensity of eosin, but are located in other chromosomes.
1. White	1. Whiting
2. Tinged	2. Cream b
3. Buff	3. Cream a
4. Eosin	4. Fourth diluter
5. Cherry	5. Fifth diluter
6. Blood	6. Sixth diluter
7. Red	7. Dark

Let us hasten to add that these seven new grades are not located in the same unit factor as are the seven primary ones; their loci are in other chromosomes (or possibly in other parts of the same chromosome.)

Here again then we have minutely differing conditions of a single shade of color, brought about by seven modifying factors. Bridges makes the following remark concerning them:

"A remarkably close imitation of such a multiple factor case as that of Castle's hooded rats could be concocted with the chief gene eosin for reduced color, and these six diluters which by themselves produce no effect, but which carry the color of eosin through every dilution stage from the dark yellowish pink of the eosin female to a pure white."[8]

Now this is an extremely interesting statement, one that must arouse the keen interest of the student of the method of evolution. In Drosophila we could get the same sort of graded results that Castle does with his rats, only in Drosophila this is by means of multiple modifying factors, whereas Castle believes that in the rat it is by actual alterations of the hereditary constitution!

But what are these modifying factors? And here we come to the astonishing point. *These modifying factors are themselves alterations in the hereditary constitution.* Bridges leaves no doubt upon this point. He lists and describes them specifically as mutations; as actual changes in the hereditary material.

Where then is the difference in principle between the condition in Drosophila and that in the rat? In Drosophila there occur minute changes in the germinal material, such as to give, so far as our present imperfect knowledge goes, seven diverse grades of a color which is itself only one grade of another series of seven known grades. By means of these graded changes one could obtain, by the mutationist's own statement, the continuously graded results which selection actually gives. What more can the selectionist ask?

There are indeed certain differences in detail, in the notions entertained by the different investigators as to exactly *where* the changes occur. Castle believes that in the rat the changes occur all in one unit—in one chromosomal locus—giving a series like the primary series for eye color in Drosophila. The supporters of multiple modifying factors believe, on the other hand—if we are to accept Bridges' account of such factors as typical (and it is the only account we have)—they believe, I say, that these minute changes have occurred in *some other* part of the germinal material. But this difference is one of mere detail; it does not touch the fundamental question.

This fundamental question is as to the occurrence of these minute changes in the hereditary constitution, and as to the possibility of getting therefrom by selection various grades of a given external characteristic.

[TO BE CONTINUED]

[7]Bridges, 1916, p. 148. (See Bibliography.)
[8]Bridges, 1916, p. 149. (See Bibliography.)

Ancient Defensive Armor in Modern Warfare*

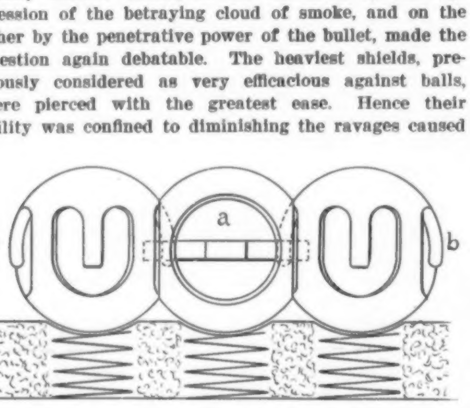
The Shield, the Cuirass and the Helmet Revived

By Nicholas Flamel

ONE of the surprising features of the present war is the increasing prominence which has been given to personal defensive armor, which it had been thought the invention of gunpowder had practically eliminated. Nicolas Flamel, writing in *Le Génie Civil* (Paris), gives an instructive account of the application of such means of protection, from which we quote below.

Cuirasses and Shields.—Our enemies the Germans and the Austrians, have always endeavored to increase the valor of the combatant by protecting him as much as possible, not merely individually, but also collectively. In 1886 the ***Allgemeine Militär Zeitung*** gave prominence to the experiments made in Austria-Hungary with bullet shields the height of a man. These could be rolled or carried to the positions to be occupied; each of these, whose total weight was 100 kilograms (2,200 pounds), was made of from 4 to 6 parts united by hinges. Bullets fired at distances of from 7 to 75 meters (23 to 244 feet) were arrested by these bucklers. There had been an effort, correspondingly, to protect a whole company by a single one of them.

But the adoption of smokeless powders, which completely altered tactics, on the one hand by the suppression of the betraying cloud of smoke, and on the other by the penetrative power of the bullet, made the question again debatable. The heaviest shields, previously considered as very efficacious against balls, were pierced with the greatest ease. Hence their utility was confined to diminishing the ravages caused



Figs. 2 and 3. Flexible cuirass Schaumann System

by balls which had already ricocheted, or whose speed had been diminished by passing through other obstacles, or by shrapnel.

Attempts at protection followed two different lines. Some endeavored to use fortuitous means without adding to the arms or equipment of the soldier; others attempted to construct cuirasses having the greatest possible resistance compatible with the very light weight which the soldier, already armed, equipped, and burdened with a knapsack, could manage.

Fortuitous Means.—The simplest idea in this direction is that which consists in taking advantage either of the knapsack carried by the foot soldier, of his digging implements, or of his clothing.

The most complete study of the use of the sack against the bullets of the infantry was made in 1901 at the Central Shooting School (Armee Schiesschule) of Bruck sur Leitha. One of our greatest chiefs, since dead, General Langlois, had also foreseen the utility of the knapsack as a shield against shrapnel balls and fragments. He thus expressed himself upon this subject:[1]

"In default of either natural or artificial shelter the haversack can be utilized against shrapnel. In fact, in experiments with the sack loaded with the marching requirements, less portable tools, the meat tin, and the mess dish, the following results were obtained:

The sack, struck normally on the back, offers resistance in nearly all portions except at the angles

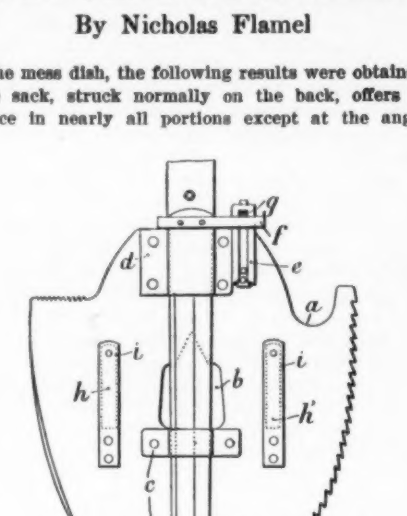


Fig. 1. Spade shield, Wiener system

when the live force of the ball is less than 60 kilogram-meters, which corresponds for the ball of:

15 grams at a speed of 280 meters
13 grams at a speed of 301 meters
11 grams at a speed of 327 meters

General Langlois later calculated the zone of protection afforded by a haversack against divers projectiles. His ideas were particularly appreciated in Germany and Austria. In the Bruck sur Leitha School experiments were made in 1901 to determine the degree of protection afforded to marksmen by their haversacks. The Mannlicher gun was used, firing with an initial velocity of 620 meters a steel jacketed ball of hardened lead weighing 15.8 grams. The preliminary tests showed that the sack provided with its full load presents the maximum of resistance to penetration by bullets, and the maximum protection, when placed upright with the flap towards the gunner. Tests were made later at long and short distances over breastworks made of several rows of haversacks. At 100 paces (75 meters), the least distance (and closer than the attacks which take place at present), a single knapsack was always traversed and afforded no protection, whatever its position. At this distance the ball has a speed of 520 meters and its demi live force is still 215 kilogram meters.

The balls traverse two knapsacks placed back to back and even a panel of wood 3 centimeters thick (cc. 1.2 inches) in addition. The protection is increased but is still not perfectly efficacious. But when 3 knapsacks are arranged jointly like three slabs of wood, even if a few balls penetrate all three, their force is spent and very often they remain within the contents of the bag, but they are found to be deformed in shape.

For tests at a medium firing distance knapsacks were arranged as follows in front of seven targets representing foot soldiers; 4 were protected by a single sack, 2 by 2 sacks and the seventh by 3 sacks. At 500 paces (375 meters, the remaining speed being about 390 meters), the demi live force of the Mannlicher ball is 122 kilogram meters. Out of 5 balls which hit the target 4 went through both sack and silhouette; one ball which struck the heel of a shoe did not go through the bag. In the case of the targets protected by two sacks one ball remained in the second sack. The target protected by 3 knapsacks was not hit.

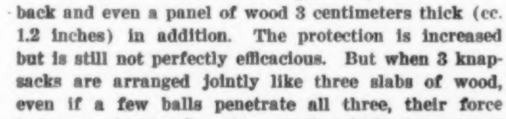


Fig. 6. Construction of the Schaumann buckler

At 800 paces (600 meters, remaining speed 340 meters), the demi live force of the ball falls to 93 kilogram meters; the targets protected by two knapsacks were not struck.

Following these initial tests there was firing at 6 targets protected by two knapsacks. At 500 paces (375 meters) the number of balls arrested was 40 per cent; at 800 paces (600 meters) the protection was over 50 per cent. and ran as high as 60 per cent. Below 600 meters a single knapsack does not give sufficient protection; two will arrest nearly 50 per cent. of the hits; three are needed for complete protection.

With much good sense the Austrians concluded that the marksman could be protected by placing his knapsack flat in front of him. At the same time he increased the precision of his aim by putting his gun on this improvised support and also lowered his visibility; the enemy's fire was rendered less precise and less effective. By throwing up a little earth in front of the knapsack the protection is notably increased and the visibility lessened.

In the case of shrapnel results were different and the Austrian Commission estimated that 50 per cent of the fragments and balls of a shrapnel shell exploding at 1,500 meters from the mouth of the gun were arrested. Langlois had likewise concluded that a knapsack either standing or lying down, especially the latter, afforded almost complete protection against shrapnel balls at 1,000 meters.

But the knapsack is not the only part of the arms or equipment of the infantryman which can be utilized for protection. He carries metal tools for digging earth. An Englishman, Clarence Wiener, has proposed[2] to make use of the trench spade as a shield for the soldier whether on march or on the firing

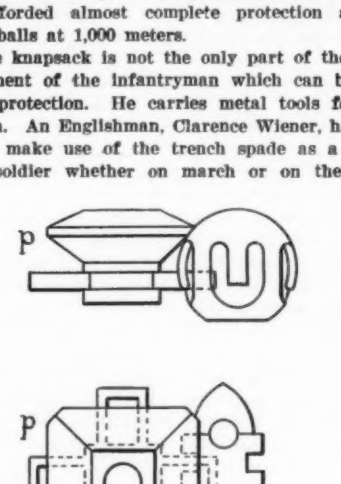


Fig. 4 and 5. Another arrangement of Schaumann system

line. In the latter case it may also serve as a gun rest. The iron part of the spade is furnished with staples to receive the blade of the bayonet, which is inserted therein and fastened (Fig. 1). The spade also bears loops which permit it to be hung from the soldier's belt. On one side of it is a notch which serves to hold the barrel of the gun when the spade is planted upright in the ground, with the bayonet fixed as a handle; it acts then as a firing bridge; it enables the soldier to handle the spade more easily when he makes use of the saw-toothed edge, or the cutting edge opposite serving as a hoe.

Fig. 1 shows how the spade and the bayonet blade are assembled, when the instrument is to be used as a spade. The spade may be square in form. The hollow *a*, referred to above, is on the right and serves as a rest for the rifle when the bayonet is fixed as shown in the figure. If the bayonet is not fixed the rifle can be inserted in the opening *b* placed in the middle of the spade. A notch, indicated by the dotted line, enables the gunner to see the sight in order to take aim.

The blade of the bayonet is held by two loops *c* and the shank of the bayonet is inserted in a socket *d*. It is held firm by means of the spring *e*; the guard ring *f* of the bayonet is threaded on the socket, and at the moment when the spring *e* is seated, a piece

*Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from *Le Genie Civil*.

[1]Artillery in Conjunction With Other Arms, Vol. 1, page 197.

[2]French Patent No. 368,076 (Jan. 10, 1908, April 4, 1908, June 3, 1908.)

passes through the guard ring and holds the bayonet in place.

Under these conditions the socket of the bayonet serves for a handle and the spade can be utilized for removing earth, sawing or cutting, and also as a shield. Placed at the end of the rifle the spade is employed as a trench tool. The spade alone, without the bayonet, can be used for the same purposes, thanks to the apertures *a* and *b*.

It is evident that the protective power of such a spade is markedly increased when the soldier has had time to throw up a little earth in front of him, even if only to the height of 0.45 meters (about 1½ feet), and, except on stony or frozen ground, this can be done in less than 2 minutes. In any case Mr. Wiener's idea deserves to be remembered, because it makes use of an instrument carried by a large number of soldiers, and does not add to the regular load.

It should be added that on the back of the spade are two loops, *h* and *h'*, which enable the soldier to fasten it to his belt so as to protect *his lower abdomen.* Flat springs *i* and *i'* hold the spade steady and keep it from pounding. Covered by the *capote* a spade thus placed is often very useful as a protection for the abdomen, wherein shell fragments do very serious injuries which are very difficult to care for immediately on the firing line. We may recall, too, that our soldiers make use of their little bags of earth, which give them a shelter for a few moments, and one whose value they increase by displacing and hollowing out the earth.

Special Instruments of Protection.—Many inventors have found it more interesting to construct special devices for protection or to improve means of protection already existing. One of the most interesting of these, and one which roused much discussion, was invented by a Greek, and was presented and patented by Mr. De Caters.[3] The cuirass in question, though it did not fulfil all the claims of the inventor, which were very difficult to realize as we shall see, was nevertheless superior to cuirasses of the same weight composed of a single sheet of steel, as were those of our cuirassiers. The inventor proposed "to increase, for a given weight, the resistance of a cuirass or a garment to penetration by any sort of projectile, so as to produce a cuirass, for example, which should be actually unperforable whatever the nature of the projectiles striking it (projectiles hard or soft, or semi-hard, or ending in a steel point); moreover a cuirass manufactured by the aforesaid method offers entire resistance to the action of water or the effects of a very high temperature; finally any projectile striking the cuirass is completely disorganized, in such manner that it does not rebound even if it strikes at a very large angle, and moreover there will be no projection of fragments around the point of impact."

As we shall see only a small part of this ambitious program was achieved. According to the inventor the results claimed were to be accomplished by the following means: The cuirass, which is made of steel, is covered by a suitable thickness of a special padding formed of a series of layers of cotton cloth or other fabric, and of certain coatings conforming to the shape of the cuirass. This is accomplished by spreading upon the cuirass a first series of parallel and united bands. These bands are covered with a layer of the said coating. Above these is spread another layer of parallel and connected bands, whose direction, however, is perpendicular to that of the first bands. On these a fresh layer of the aforesaid coating is then spread. The bands are sewed together to unite them firmly, and this operation must be completed before the coating is dry, since the application when dried is too hard to permit of sewing. The coating is composed of strong glue with which is incorporated, in proper proportions, a mixture, in practically equal parts, of black rosin and wood tar. Upon this first layer of the coating then is applied a second layer formed of one part of borax to 3 parts of colophane (black rosin). The ensemble is molded upon the cuirass, dipped in an impregnating bath, drained, compressed and dried. It is then applied to the cuirass by enclosing the two in a close fitting envelope. Naturally the inventor contemplates the employment of agglommerants other than wood tar; but we confess ourselves unable to see the utility, from the defensive point of view, of compounds rich in very active oxygen (perborates, etc.).

On being tested the above cuirass behaved very well, even without the steel plate, so long as it was a question of revolver bullets or the stroke of steel. To be efficacious against rifle balls it is necessary for it to attain, together with the steel plate, a considerable weight. But it is an incontestable fact that, thanks to the surface cushion, there was no ricocheting.

The balls which ricochet or rebound from the chanfrein (horse armor) of our cuirassiers are often more dangerous to the cavalryman than the

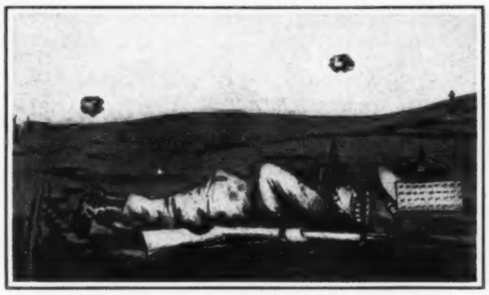


Fig. 7. German infantryman using a buckler

balls that strike his own cuirass. They are deformed and strike the rider on head or neck. A simple piece of cloth glued to a steel plate prevents balls from rebounding; they penetrate the cuirass directly, and if this is sufficiently resistant to arrest them the protection is satisfactory. But to stop the German balls, especially the perforating balls with a nucleus of tungsten steel, which are supplied to many gunners, the thickness of the steel must be considerable.

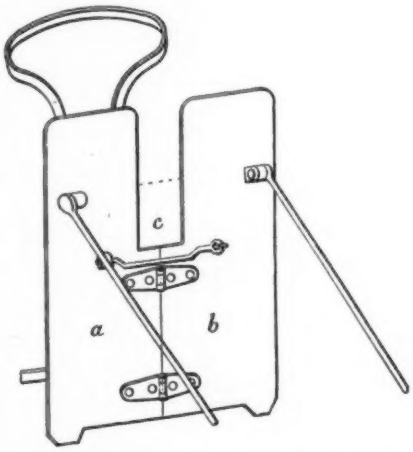


Fig. 8. Buckler, Sierra Lensa system

Another solution has been sought, and a German has attempted to make a flexible cuirass and a rigid cuirass, or more exactly, a shield. December 11, 1908, Oskar Schaumann applied for two patents,[4] one for a flexible cuirass, the other for a rigid cuirass, both proof against balls. Less than a year later, November 26, 1909, the same claims were registered in France.

The flexible cuirass was constituted by a combination of elements united like the meshes of a net This ensemble was superposed upon an elastic net.

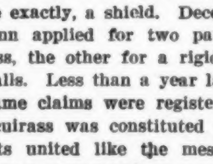


Fig 9. Armored shelter, Farner system

The inventor hoped, by multiplying elastic shock absorbers, to absorb the live force of the fastest ball. The meshes of the elastic net were constituted by spheres joined with each other by hooks or eyes. The spheres were capable of preserving their entire mobility with respect to each other, and yet the hooks permitted the little spheres to approach each other as closely as possible, in order to obtain a very united surface and to allow the spheres near the point of impact to absorb a portion of the live force. To make the whole as light as possible the balls are hollow.

The elastic cushion is formed of springs applied underneath each sphere, or of a flexible pocket filled with shreds of rubber. Figs. 2 to 5 show how the spheres *b* are assembled in groups of 4, with an interior sphere *a* cut out and provided with hooks so as to fix the spheres. The cushion *e* is a combination of springs and of pockets filled with rubber. In place of spheres the pyramids *p* and cylinders can be placed side by side as shown in Figs. 4 and 5, or else scales like fish scales, coats of mail, such as other inventors have essayed.

The conception of the rigid cuirass, presented by the same inventor, derives from a quite different principle that adopted for the armor of the Harvey type. The cuirass, instead of being formed of a single plate, is constituted by the superposition of plates whose hardness and density steadily diminish from the side where the impact of the projectile takes place to the side nearest the wearer. The inventor thus describes it:

"To obtain by means of this invention a complete guarantee against the penetration of pointed projectiles, there may be applied, furthermore, to the cuirass proper, a thin plate of extreme hardness, upon which the point of the projectile will be broken, so that thereafter it will behave like a blunted projectile with respect to the cuirass itself, and will be arrested by the latter, leaving only a slight mark upon it."

The different plates may be three in number: the first *a* of steel (Fig. 6), the second *b* of aluminum or duralumin, the third *c* of celluloid or horn. The hard plate of steel may itself be less hard on the side in contact with the cuirass proper, with the object of avoiding rupture. Finally one may also interpose a softer substance (silk, asbestos) between the cuirass and the protective layer to deaden the penetrative force of the projectile. Hence there may be from 3 to 5 layers of different kinds.

The results obtained from the flexible cuirass seem to have been not very remarkable, since the inventor achieved no renown. But the rigid cuirass is another matter. In 1912 the *Journal of the United States Artillery* noted that the same Mr. Schaumann had constructed a new type of cuirass, or portable shield, whose results were particularly interesting with respect to tests of the German S ball.

This buckler was constructed on the type of the Harveyized cuirasses; as we know, the external part of these cuirasses is of very hard steel, the internal part of a soft and plastic steel. With these cuirasses the following results were hoped to be obtained, and were in fact obtained: the projectile, in contact with the hard portion, is deformed, the surface of the section of penetration being increased in size the armor is the more easily able to arrest the ball. The rear portion, which is softer and more plastic, holds in place the external part, which is hard, and therefore brittle.

Mr. Schaumann's cuirass, as described above, is made as follows: a plate of hard steel is backed by one of the most interesting of the aluminum alloys, duralumin, whose method of preparation has been known in France for only a short time. The two plates are joined by welding or, better, by means of rivets.

In Germany tests with the S ball gave the results below:

Thickness in Millimeters		Firing distance	Observations
Anterior steel plate	Duralumin plate		
6	6	30	The shield is merely dented with a swelling but no fissure.
6	0	30	Shield perforated by a large hole.
4	6	50	The two portions come apart, and a fissure is produced, but the shield is not penetrated.
4.5	6	50	The shield remains intact; there is a slight swelling, but no fissure.

The weight of a double cuirass (4 millimeter steel plate, 6 millimeter duralumin plate), is the same as that of a six millimeter steel plate, the density of duralumin being a third that of the steel. Its re-

[3] French Patent No. 439,493 (April 10, 1911, April 11, 1912, June 14, 1912.)

[4] French Patents Nos. 410,006 and 410,007.

sistance equals that of a steel cuirass 7 millimeters thick; hence there is an economy in weight of one-seventh in the latter plate, or, with an equal weight in a plate of 6 millimeters thickness, there is an increase of one-seventh in the resistance.

Following these tests Schaumann endeavored to obtain doubled plates of the same resistance as the best cuirasses of Krupp steel, formed of a single plate, but of a quarter less weight, and even a third. No very precise information has been given out concerning the new Schaumann plates, but it is quite certain that the Prussian Department of Artillery Technology has studied a portable buckler made after the ideas of Schaumann. This portable buckler can be fastened by two leather bracelets to the left forearm. It is formed of a plate of hard steel riveted to a plate of duralumin by rivets having a slightly projecting point in the form of a mushroom. Its protective power is greater than that of a sand bag and it is easier to carry and does not interfere with the motions of the gunner. This shield had not been perfected, and consequently not furnished to the troops, at the time Germany declared war. This is why we have not seen it make its appearance, all the duralumin having been reserved for the construction of Zeppelins. Fig. 7 shows how the infantry man could use it. His hands remain free, while with the sand bag he is obliged at times to make use of both hands. Such bucklers would be of the greatest service to grenadiers and would not interfere with the throwing of bombs.

Rather heavy bucklers like that of Messrs. Sierra Lensa[5] have been proposed. In the opinion of the inventors this portable shield, shown in Fig. 8, would enable troops to dispense with trenches and avoid the carrying of all implements. It is formed of two sheets of thin steel fastened together by hinges. An opening *c* permits the passage of the gun barrel, and the buckler serves at the same time as a rest for taking aim. This buckler was specially designed for the divisions of machine gunners who might open fire on a flat terrain.

Besides these means of individual protection, methods of collective defense have been devised which recall the Austrian bullet shields. The armed and iron bound armor plate of Lossier[6] increase the defensive value of the trenches. And with respect to this Ulrich Farner[7] has gone much further. According to the inventor this is a genuine movable defensive shield, permitting the rapid organizing of important points. Fig. 9 shows elements which permit the construction of an armored shelter.

It would seem futile to pass in review all the propositions which have been made. But before the war in France only the artillery which could not easily change position, which was obliged to cling to the terrain and which formed the framework of the field of battle, had shields to protect the gunner, the pointer and his caissons, and in some regiments, helmets. The heavy artillery, almost non-existant, and less mobile than field artillery, had nothing.

Helmets.—Steel helmets or casques have been of service, no matter how thin or how heavy, but they afford incomplete protection to the eyes and temples. Shell fragments do not always strike in a downward direction but oftener follow the opposite direction. To protect eyes and temples a visor would be necessary in many cases. Improvements will certainly be made and are already begun, indeed.

Perhaps helmets might be made of raw hide, or of chrome leather, rendered impermeable, as was proposed in 1907 by a captain of artillery. They would be less heavy than steel and often quite as efficacious.

After having adopted the *casque* and witnessed its service it would appear logical to seek to enlarge the defenses of the foot soldier by covering his abdomen, his neck and his thighs, where essential organs or large arteries are located. Not all officers have thought it impossible to protect the soldier, especially the infantryman, because bullets have acquired greater speed and power of penetration. Rifle balls are not the only things to be feared. Many soldiers are victims of fragments of shell, shrapnel and grenades, revolver balls, wounds from metal weapons, etc., and the majority might have been successfully protected and saved from a futile death.

In the National Conservatory of *Arts of Métiers* may be seen a very light cuirass made of two or three thicknesses of buffalo leather superposed and joined together. Each of these skins sufficed to stop a revolver bullet fired at very close range. This same cuirass bears the marks of bayonet and saber which did not succeed even in scratching the second skin, in spite of the vigor of the lance thrusts and the point of the fencer with sword and bayonet who tried to damage it. This cuirass would probably have arrested balls or fragments of shell or grenades. It was presented in 1908 by Captain Nicolardot, who had proposed its use for a light helmet and cuirass in 1907, and repeated it in the course of a lecture given in 1908 at the National Conservatory of *Arts et Métiers.*

That the idea of making cuirasses of leather is not novel is indicated by the word itself (*cuir*=leather in French). The bucklers of other days were made of specially prepared bull hide; but the skin simply dried, parchmented, raw hide, is even more resistant than leather which has undergone tanning or any other process whatever. Therefore a Lille manufacturer, Mr. Boulanger, conceived the idea of using this material for arresting bullets. His tests were unsuccessful. At 200 meters the bullet from a rifle of the 1886 model penetrated to a distance of 35 millimeters in a block made of pieces of green buffalo leather glued together. The insertion of a metallic lattice caused no appreciable improvement. It should be noted, however, that weight for weight the leather afforded better protection than the steel. But such tests led to the abandonment of leather as a protection.

Other tests with raw hide and mineralized leather gave similar results, and this will always be the case *so far as arresting bullets is concerned.* The experiments of Commandant and Nicolardot, of Chief Surgeon Vennin, and of Professor Richet all confirm this precisely.

It was with entirely different views that Captain Nicolardot proposed in 1907 the making of helmets and abdominal protectors of raw hide enclosed in an impermeable envelope. His idea was to protect the police against revolver bullets and cold steel. Would it not be worth while at the present time to protect the soldier's heart and abdomen by a shield of raw hide? Might not a part of the knapsack itself be made of this material?

There are in existence stocks of buffalo hides which are little utilized.

Tanned leather, and chrome leather especially, made impermeable by paraffine, or better, by oils which have been hardened or transformed in part, would do at a pinch; but its resistance is less than that of raw hide for equal thickness or weight. To show the value of leather for defensive armor we need but state that out of 100 mortal wounds only fifteen are due to rifle bullets.

[5]French Patent, No. 429,600 of May 12, 1911.
[6]French Patent No. 409,621 of Feb. 23, 1909.
[7]French Patent No. 438,663 of Jan. 4, 1912.

Notes on Welding Systems*

A PAPER on welding systems was delivered recently by Capt. Jas. Caldwell before the Institute of Engineers and Shipbuilders, at Glasgow in which he spoke as follows on welding with coated metal electrodes:

(*a*) *Gaseous Flux Process.*—In this process, which was originally patented and developed by Kjellberg, the metal electrode is covered with a fireproof sleeve of non-conducting material, so that as the metal is removed by the arc the sleeve projects beyond the end of the rod, forming a guide for the molten welding metal, the sleeve itself falling away automatically. This sleeve also protects the metal from oxidation and reduced heat losses.

It is an improvement on the bare metal electrode, and a great deal of satisfactory work has been done with it, namely, in repairing marine boilers, stern frames and other ship parts. . It is also successfully used to build up worn parts, such as propeller shafts, worn crankshafts and axles, which are afterwards machined to size. The patent claims the use of no particular material for the fireproof sleeve, and no other purposes than those mentioned, but the company exploiting the process claims that it can be made the vehicle of constituents which will give desired characteristics to the added metal.

(*b*) *Liquid Flux Process.*—In this process, invented by Strohmenger of the Quasi-Arc Company, a sleeve or covering is applied to the electrode, and the material of this sleeve is such that it melts and forms a flux covering the end of the electrode and the added metal, thus protecting both from oxidation. The flux may contain constituents having a chemical action upon the fused metal, to improve its qualities. As originally used, the electrode was laid along the line of the weld, connected to one pole of the circuit, and an arc started at one end which travelled along the line fusing both the work and the electrode metal and leaving the weld covered with the flux. It was found better, however, to clamp the rod in a holder, moving it by hand along the length of the weld at a suitable rate and giving it at the same time a swinging movement across the line of weld, as is done in blowpipe welding. The arc is formed entirely within a sheath of molten flux, so that the metal is at no time exposed to oxidation. The arc is very short, about ¼ in. as a rule. Incidental advantages of this method include smaller heat losses from the arc, and that work can be done with a lower expenditure of energy than by any other arc method.

The covering material used generally has asbestos as a basis which is impregnated with salts calculated to combine with the asbestos to form a mixed silicate flux or slag of suitable viscosity and with the property of cleaning the metal surfaces from oxide, &c. The viscosity of the molten slag is of importance. It must be sufficiently fluid to permit the free movement of the rod working in it, and to free itself from the molten metal, but not so fluid that it is blown away from the weld by the gases escaping from the arc. Different makers use different compositions, and it is probable that some variation is desirable to suit different metals. Some experiments are being made with fluxes of a "basic" character instead of "acid" silicates, presumably to reduce the amount of silica in the metal. In some cases the fluxing material is put on the electrode rods in a plastic condition by forcing through dies, and in other makes part of the flux constituents are placed in the form of a powder in a tubular or channel electrode.

The material of the rod can also be varied to suit the work. For example, nickel-plated rods are made for the special purpose of welding high-speed tool steel into mild steel shanks. Compound rods are made, and an aluminium ribbon or wire is sometimes wrapped round the rod, before the flux coating is applied. Since the fused electrode metal is protected from oxidation by the flux it can be so compounded as to give a welding material of any desired composition, which is of considerable importance when the weld has to resist high stresses, or when the added metal has to act as a reinforcement or has to be machined to form a working part or surface. There is a great deal of experimental work in process on these lines, and whilst some of the results may have little more than advertising value, others of material importance have already become known.

The fluxed metal arc process is certainly of the greatest promise for constructional welding, as for example, in shipbuilding. Trials already made on full scale show that in some respects it is superior to riveting. Actual experience in ships in service is wanted to show whether these last results are borne out in practice, because no testing machine can reproduce the complete stresses endured by a ship in service. There is already good reason to say that if welding can replace riveting there will be a considerable saving in material and labor in shipbuilding. Whether an all-welded ship is practicable or not, this method of welding is satisfactory for a large number of constructional details.

Butt joints must be suitably prepared by veeing and fitting. Plates under ¼ in. thick need not be veed, as complete fusion for this depth can be assured. The angle of the V should be no larger than to permit the end of the electrode to get well down to the lower surface. In thick work it is usual to apply several layers to get full thickness. The slag should be removed from each before another is applied, and the surface brushed bright with a wire brush.

The rod is held at right angles to the face of the work. Care is necessary to maintain the arc at the proper length. If the electrode touches the work it will probably stick. It should be fed down at the rate at which it melts, or the arc will break from the great length. Excessive length of arc, short of the breaking point, tends to produce porous metal. The rate of feed along the joint should be steady so as to produce a layer of even thickness. Interruptions should be avoided, and when unavoidable—as in coming to the end of an electrode—the metal should be thinned out for a short distance and thoroughly re-fused when starting again. The light and heat given off from the fluxed metal is much less than from the carbon arc, but screening of the face is necessary to protect the eyes from glare and sparks by tinted glass let into a light frame which is held in the hand.

*Extract from a paper read on January 22, before the Institution of Engineers and Shipbuilders in Glasgow.

War Psycho-Neurosis—II*

The Psychology of Soldiers' Dreams

By F. W. Mott, M.D., LL.D., F.R.S., F.R.C.P.

[Concluded from Scientific American Supplement, No. 2202, Page 163, March 16, 1918]

I have asked numbers of soldiers and officers to write down their recurrent dreams for me, and I possess a considerable number of such records. Almost without exception they have a direct relation to war experiences. This method avoids suggestion on my part by putting leading questions. I ask them to state how far the dream is related to previous experience and whether any particular dream or dreams constantly recur. I tell them that a correct description in writing will prove a valuable means of throwing off the terrifying effects. In only one instance was there any pronounced sexual basis; the subject of that particular dream, which constantly recurred, was of a disgusting and horrible nature, and when it occurred gave rise to most distressing hysterical manifestations. The patient was a private and wrote down the nature of this dream on condition that I would never make it public. Whether, as he affirmed, he had actually witnessed the scene, or whether, as is possible, it was gross exaggeration, or a delusion arising from a recurrent dream, I am unable to say.

In one case, however, the patient when just dozing off was disgusted by the smell of dead bodies, and this smell was followed by horrifying visions of putrified corpses. He explained it by the fact that he had been serving some time at the front, and the continuous shell fire had shattered his nerves, rendering him unable to continue to fight in the trenches, and he had latterly been employed in burying the dead.

A very common complaint of soldiers is a falling feeling; this is not limited to men in the R. F. C., although it is usual for them to dream of their especial experiences. A not infrequent dream is that they are engaged in bombing or fighting; that their machine is hit, and that they are descending in an aeroplane in flames. It does not necessarily mean that this has been their experience, but the anticipation of the possibility of such a catastrophe from the knowledge of the fate of others has left such a deep impression on the mind that the imagination provides the source of the terrifying dream.

A very remarkable dream of an officer of sound nervous constitution is worthy of full consideration, and I will merely record what he wrote, for it clearly shows his dream accords with his experience, and it illustrates how true is the observation of Lucretius:

"And generally to whatever pursuit a man is closely tied down and strongly attached, on whatever subject we have previously much dwelt, the mind having been put to a more than usual strain in it, we for the most part fancy we are engaged in the same."

This is the one instance in which an individual has dreamt the experience of hunger and thirst in addition to battle experience.

RECORDED DREAM OF A SECOND LIEUTENANT

"During the five days spent in the village of Roeux I was continually under our own shell fire and also continually liable to be discovered by the enemy, who was also occupying the village. Each night I attempted to get through his lines without being observed, but failed. On the fourth day my sergeant was killed at my side by a shell. On the fifth day I was rescued by our troops while I was unconscious. During this time I had nothing to drink or eat, with the exception of about a pint of water.

At the present time I am subject to dreams in which I hear these shells bursting and whistling through the air. I also continually see my sergeant, both alive and dead, and also my attempts to return are vividly pictured. I sometimes have in my dreams that feeling of intense hunger and thirst which I had in the village. When I awaken I feel as though all strength had left me and am in a cold sweat.

For a time after awaking I fail to realize where I am and the surroundings take on the form of the ruins in which I remained hidden for so long.

Sometimes I do not think that I thoroughly awaken, as I seem to doze off, and there are the conflicting ideas that I am in a hospital, and again that I am in France.

During the day, if I sit doing nothing in particular and I find myself dozing, my mind seems to immediately begin to fly back to France.

A dream that keeps on coming up in my mind is one that brings back a motor accident I had about six years ago, which gave me a severe nervous shock. I had, of course, entirely forgotten about it, except when in a motor, when I always thought of it.

Of the fifth day I have absolutely no recollections."

*A lecture delivered before the Psychiatric Section of the Royal Society of Medicine (Great Britain) and reproduced from *The Lancet*.

EFFECTS OF THE DREAM THE NEXT DAY

As these dreams are nearly all of a terrifying or horrifying nature, and connected with the emotion of fear and failure of the defensive reactions of self-preservation, the subjects of them awaken with a feeling of dejection and pallor; they have, as Shakespeare says, "Lost their fresh blood in the cheeks."

A dream recorded by one officer is therefore of psychological interest in this respect as showing that a dream of a successful struggle for life with an enemy under terrifying circumstances may give rise to a feeling of exhilaration on waking; whereas the same officer when he dreamt of a scene that he witnessed causing horror gave rise to a feeling of dejection.

These two dreams, which recurred at intervals, were based upon two separate experiences. The one related to the existence of the legless body of a Prussian that lay for days in front of their dug-out, and which it was highly dangerous, as it was found to their cost, to remove. The other related to a fight with a Prussian who threw a bomb which just missed him and exploded out of harm's way; he threw a bomb which blew the enemy's head off just as the Hun was preparing to throw another bomb at him. A repetition of the state of feeling that actually happened during life must be assumed to have occurred as a result of the dream.

ANALYSIS OF DREAMS WITH INCONGRUOUS ASSOCIATIONS MAY REVEAL AN EMOTIONAL ASSOCIATION

I could multiply instances of memories of particular experiences recurring in soldiers' dreams of a similar character to those related, and I think I have shown that when Shakespeare speaks of dreams born of fantasy, children of an idle brain, he was clearly not referring to the dreams of soldiers who had recently been exposed to all the emotional shock of battle, but to those experiences of past life which had been broken up and dissociated into elemental perceptual parts which are linked up in incongruous association.

Apparently incongruous association may by careful investigation reveal an emotional association; thus a present fear experience may be associated with a past and forgotten fear experience, as the following dream shows:

An officer who had served in South Africa told me that he had had a dream from which he awoke in a fright. He was in a mine passage at the front when he met a leper who came towards him. Upon questioning him and asking him if he could recall some period of his life in which his mind had been disturbed by a leper, he remembered that in South Africa he and his comrades were much alarmed, and vigorously protested against a leper being allowed to remain in an adjoining sangar. Evidently this had left a deep impression graven on the mind; the principal subject, the leper, was dissociated from concomitant experiences in the South African war, and became linked up with a recent terrifying experience of being in a mine passage, which likely enough was also an experience in which the emotion of fear occurred. Both incidents, suffused with very strong feeling, in all probability were deeply graven on the mind and became firmly fixed by subconscious association.

Another case is the following, in which the dream appeared to have an incongruous association of dissociated experiences, but in which there was a natural association of primitive emotions.

A sergeant, who had been a schoolmaster, was asked to write down his dreams by Captain W. Brown, who had sometimes charge of my cases at the Maudsley Hospital. The first was as follows:

"I appeared to be resting on the roadside when a woman (unknown) called me to see her husband's (a comrade) body which was about to be buried. I went to a field in which was a pit, and near the edge four or five dead bodies. In a hand-cart near by was a *legless body*, the head of which was hidden from sight by a slab of stone. (He had seen a *legless body*, which was covered with a mackintosh sheet, which he removed.) On moving the stone I found the body alive, and the head spoke to me, imploring me to see that it was not buried. Burial party arrived, and I was myself about to be buried with legless body when I awoke."

The second dream was as follows:

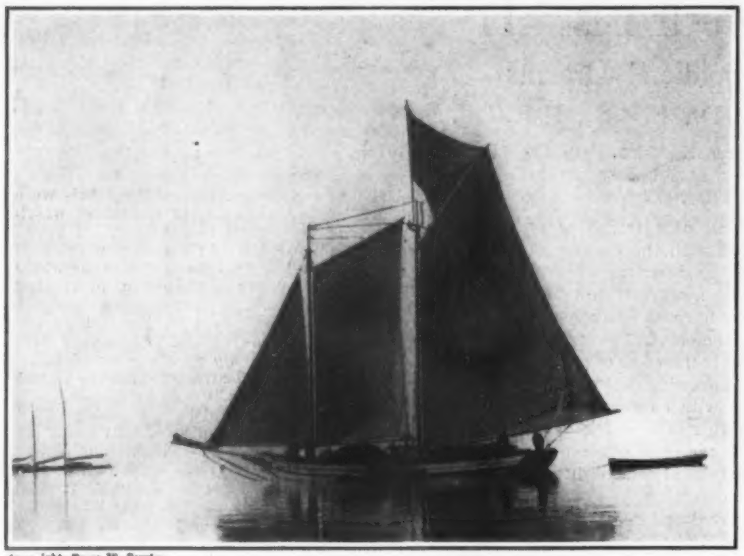
"After spending an evening with a brother (dead 11 years ago) I was making my way home when a violent storm compelled me to take shelter in a kind of culvert, which later turned into a quarry, situated between two houses. Men were doing blasting operations in the quarry, and whilst watching them I saw great upheavals of rock, and eventually the building all around collapsed (explosion of a mine). Amongst the debris were several mutilated bodies, the most prominent of which was *legless*. I tried to proceed to the body, but found that I was myself pinned down by masonry which had fallen on top of me. As I struggled to get free the whole scene appeared to change to a huge fire, everything being enveloped in flames, and through the flames I could still see the *legless body* which now bore the *head of my wife*, who was calling for me. I was struggling to get free when *my mother* seemed to be coming to my assistance, and I awoke to find the nurses and orderlies standing over me."

It appears that the patient had been shouting in his sleep, beginning in a low voice and gradually becoming louder until eventually he was shrieking. The *legless body* occurred in all his dreams; the sight of this had evidently produced a profound emotional shock. He had worried a great deal about his wife, who was much younger than himself, so that we have this incongruous association of the *legless body* and the *head* of his wife calling him; finally, what more natural than the *mother* to come to his help. The emotional complex is not incongruous in this dream, for fear is linked up with the tender emotion.

Psycho-analysis, or the unravelling of the origin and the relation of these dreams to disorders or disease of mind and body, I do not intend to discuss, nor the value of psychotherapy, but I am inclined to agree with an eminent Italian psychiatrist, Lugaro, who, in the review of "Shell Shock and Its Lessons," says: "The people who can touch psychic wounds with delicacy and sympathy are extremely rare, especially among doctors."

Films of Metals and Salts In Glow Lamps

Professor W. Reinders, of Delft, and Mr. L. Hamburger, of the Eindhoven Laboratory of Messrs. Philips' Carbon-Filament Lamp Works, have submitted the sublimation deposits which form on the inside of incandescent lamp walls to examination by the ultramicroscope. The deposits consisted either of the carbon or the metal of the filament, or of the salts with which the tungsten filaments were covered. Peculiarities noticed in the case of salt deposits, common salt, sodium oxide, sodium tungstate, etc., make it advisable to mention their case first (Proceedings, Amsterdam Akad., Wetenschapen, 1917, pages 958 to 968). The film of salt settling on the wall was colorless and invisible as long as the bulb remained intact. Under the ultramicroscope the deposit appeared optically homogeneous, and like a vitreous undercooled layer, from 0.0003 mm. to 0.001 mm. in thickness. When the bulb was opened, so that the moist air gained access, the film turned opalescent, the ultramicroscope began to reveal a network texture, and after some hours cubic crystals could be distinguished. In order to preserve the still homogeneous film for future study, the authors admitted Canada balsam into the bulb; then the slow crystallization of the salt took place only in the spots which were not covered by the balsam. When a silver filament was heated to red glow by the current, a film settled on the glass which was first yellowish-green, and passed through orange, red, violet and blue as the thickness increased. An absolutely homogeneous film was not observed, but the yellow deposit consisted of smaller particles than the red and blue; these colors agree with Rayleigh's studies of 1871. According to Knudsen the metallic vapor particles impinging upon glass walls are not reflected when the walls are cooled; in the case of mercury Knudsen did not observe any reflection when the glass was cooled to — 135 deg. C., for silver Reinders found the lower limit of reflection, that is to say, the temperature at which all the vapor condenses on glass, at 575 deg. C. Gold resembled silver in its behavior, the color of the deposit changing with its thickness. Tungsten gave only grey or black deposits. The first film of tungsten was, indeed, colorless; films of a muddy grey color consisted of particles of about $0.5 \mu\mu$; there seemed to be no reflection of tungsten particles by the glass wall, which accords with Langmuir's observations. Reinders and Hamburger also experimented on the kathode volatilization of metals by suddenly sending powerful currents through loops of thin wires. The films then obtained were coarser in structure than the evaporation films; the tungsten films were always black, and the particles had diameters ranging from 2μ up to 5μ; with slow volatilization finer particles were also obtained, however.—*Engineering*.



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A typical oyster boat showing sail, rigging and hull-lines of craft engaged in the fisheries of the Gulf of Mexico

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The catch is inspected by a government official to guard against the marketing of small and immature oysters

Oysters: The Food That Has Not "Gone Up"*

A Little of Their History and Their Habits of Life

By H. F. Moore, Deputy Commissioner Bureau of Fisheries

AN animal food which practically has not increased in cost for 25 years, and the production of which has kept pace with the growth of population, is a present-day anomaly worthy of public attention; especially when its price brings it within the reach of all and its excellence leaves little to be desired. This is the case of the oyster, probably the only food animal which has not shared in the general increase in the cost of commodities. The oyster of the multitude is better than ever and about as cheap. Compare these facts with the 25 to 75 per cent increase in the cost of eggs, poultry, and meats.

In Europe the oyster is, and long has been, a luxury enjoyed by the few. When the first settlers came to the shores of America, one of the most impressive indications of the richness of the new land was the great abundance, large size, and excellence of the oysters which they found. Under these conditions, and at a time when the infant communities necessarily were dependent in a great measure on natural products for food, this readily obtainable and delicious shellfish came into common use as an important element of their diet. Even before the white men came, the Indians of the coast subsisted largely on oysters, and, it is said, used them in a dried and smoked state, strung on twigs, as an article of barter with their inland neighbors. At many places great mounds of shells deposited in prehistoric times tell of the free use which the red man made of oysters, and on the Damariscotta River in Maine, where none are now found, there is a mound containing about 7,000,000 bushels of shells.

The early white settlers, like the Indians, relied on the supposedly inexhaustible natural beds; but in the older and more densely populated parts of the country, particularly on the New England coast, where the natural beds were less extensive than farther south, the almost universal use of this popular shellfish by the coastal population showed many years ago that nature, in many cases wantonly abused by wasteful methods, could not keep up the supply unaided. It was obvious that lest the supply should fail, at least locally, man himself must lend a hand much as he had in raising land crops.

The oyster, as most persons know it, is as immobile as the turnip and like that stolid vegetable is attached to the soil, although not by roots; but in its infancy it swims freely, though feebly, and before it settles down may wander far from the parental locality. The embryo oyster, which forms after the egg is discharged into the water by the mother, is so small as to be just visible to the unaided human eye. This embryo soon becomes covered with microscopic fleshy bristles, which, beating in unison, give it some power of locomotion, though they are serviceable chiefly in suspending it in the water and bringing it within reach of the tidal currents which waft it afar.

After a brief career of travel a tiny shell begins to form, and as the burden of this increases a change of habit comes. The little oyster must attach itself to a support and settle down to the sedentary life of the adult, and this necessity brings one of the gravest crises of its life. It is hardly visible without a lens and the thinnest film of sediment will cover and stifle it, and most of the bottom over which it has been swimming is muddy. Only oyster beds, gravel and shells, piling, and similar bodies in the water present a surface sufficiently firm and clean to serve the little oyster's purpose. The more fortunate ones cement their shells to such objects, grow, and henceforth remain where they fell unless displaced by some external force; but for each one which becomes so attached there are unknown myriads which fall on unsuitable surfaces and perish. This is one reason why it is necessary for the female oyster to produce millions of eggs that her kind shall not disappear.

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Running a car of oysters into a steam chamber for cooking

The men who first undertook oyster culture in America did not know these things, nor many other interesting facts of the oyster's life; but they had observed that almost any hard-surfaced objects falling into the water, if they did not become engulfed in the mud, became coated with a growth of oysters, and they reasoned that such materials purposely placed on barren bottoms would establish artificial oyster beds and that to the man depositing belonged the oysters.

Thus began, through the initiative of the oystermen themselves, the practice of oyster culture in the United States, which has developed until at the present time about one-half of the oysters produced in the country, nearly two-thirds of the total value of this product, are derived from artificial beds, privately owned or leased from the states.

Beginning in shoal waters alongshore, the oyster growers have extended their operations into the deep open waters of Long Island Sound and Chesapeake Bay and to every coastwise state from Massachusetts to Texas and from Washington to California, and the few small boats first employed, propelled by sails or oars, have given place to fleets of motor boats and steamers. In 1911 planters spread 17,000,000 bushels of young oysters, shells, and gravel over their 500,000 acres of oyster farms; and they harvested a crop of over 15,000,000 bushels of oysters, worth to them approximately $10,000,000.

Between the planting and the harvest, an interval from two to five years, the oyster culturist assumes many hazards. On the New England coast, after all his material is down, the fickle "set" may not appear, possibly because at the critical time some weather disturbance may have killed the baby oysters while they were yet swimming near the surface. In the Gulf of Mexico the "set" may be so heavy that there is scant room for the oysters to grow, and many die while those that are left are half starved and misshapen from crowding. Even when the little oysters or "spat" have attached themselves in favorable numbers, their perils have just begun. They are never safe from other enemies until they fall into the hands of their arch foe, man. Schools of drumfish may grind them into fragments between teeth arranged like a cobblestone pavement, and so the oyster grower's crop may melt away, almost in a night. Starfish often appear in great hosts and by the muscular force of their arms furnished with rows of suckers, rend open the shells and turning their own stomachs inside out absorb the oyster while it still lies within the armor designed to protect it. The drill, a little marine snail, uses its rough tongue like a rasp and, boring a smooth round hole through the helpless oyster's shell, inserts its snout and licks up the delicious meat within.

Freshets from the land and storms rolling in from the sea take their toll—the one by rendering the water too fresh or too muddy and the other by the force of the waves tearing up both oysters and the bottom. Even with their own species these mollusks have to contend,

*From *Economic Circular* No. 18, issued by the U. S. Bureau of Fisheries.

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Culling and opening oysters for direct shipment. These men are experts who receive a cent for each oyster opened

Comfortable quarters furnished free of rent to the force of oyster workers at Biloxi, Miss.

and numbers uncountable die in the warfare. They struggle with their kind as man struggles with man, for room to grow and enough to eat; and though the struggle is passive it is relentless, and the loser, unable to run away, is starved or stifled through lack of room in which to open its shell for food and oxygen.

The oyster feeds on small particles suspended in the water, conspicuous among which by reason of their beauty under the microscope are minute plants, called diatoms, covered with ornately sculptured transparent shells of quartz. These and the other food particles are carried by the currents, dropping to the bottom in a gentle drizzle and eventually accumulating in considerable deposits. Each oyster has part of its surfaces covered by innumerable microscopic, vibrating, fleshy bristles, each feeble in itself, but beating in unison, producing currents strong enough to carry the food particles into the gaping shell, where the water passes through the gills, which are beautifully constructed delicate sieves, and thence again to the outside, while the food strained from it passes in a constant stream into the mouth. So industrious is the oyster and so scattered is its food that to get its daily meal it filters between 25 and 35 quarts of water, making useful to man a wealth of microscopic material which otherwise would be lost. The waste of the soils, washed by rains and carried into the sea, comes back, indirectly, through the marine plants that are nourished by the fertilizing salts and fed on by the oyster.

If food be abundant and the beds not too crowded, the oyster becomes fat, luscious and tender. In this condition it is one of the most inviting of foods and one of the most digestible, nutritious and wholesome, and its composition is of such character as to make it more nearly than most foods self-sufficient as a diet. In this respect it resembles milk and needs but the ordinary ingredients used in cooking—starches and fats—to give it "balance." It is remarkable among ordinary food substances in its high proportion of glycogen, a substance resembling starch but more readily and easily assimilated, and, unlike starch, wholly digestible even when uncooked.

With all of its manifold merits, it never has come fully into its own, partly because until recently the people of the interior have not been able to get it at its best, but largely because it has been the victim of prejudice. Eaten raw, the oyster, like most other uncooked foods, may carry disease if taken from polluted surroundings. A few such cases have been given great prominence, and to a considerable extent the oyster has fallen in public esteem; but though this has unnecessarily deterred many persons from using an excellent food, it has not been without good results. The United States and many State and municipal governments have awakened to the advisability of supervision and inspection, and there is now exercised a close scrutiny of the sources of oysters which are brought to market or shipped from State to State and of the methods of handling and transporting them. It can be said that oysters to-day are more sanitary and better than ever and that there is, at least, as sufficient a guaranty of their wholesomeness as there is of milk, strawberries, lettuce, celery and other foods not usually cooked for consumption. If the oysters be cooked there is a double guaranty.

In other countries oysters are nearly always eaten raw, and even in this country the finest are usually consumed in this way as a minor course at meals; but the distinguishing feature of their consumption in the United States is that they are generally cooked and constitute an important part, if not the whole, of the meal at which they are served. Under these circumstances manifold methods of cooking them have been evolved, and a number of these are given in the circular from which the above facts are derived.

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After being cooked by steam the oysters are removed from their shells and canned

The illustrations accompanying this article were taken at Biloxi, Miss., which is now one of the greatest oyster markets in the world. Hundreds of boats from the extensive beds in the Gulf of Mexico arrive at this port every day, where the largest and best of the catch are at once opened for immediate shipment on ice; while the smaller oysters are cooked by steam and canned. Many hundreds of workers are employed in the fisheries and the canning establishments, and these are comfortably housed in quarters owned by the canning companies, who charge no rent, but also furnish light and fuel free to their employees.

Gas Firing and the Glass Industry

IN the old types of glass furnace, where the fuel is burnt close to the work, the heat available is only a small percentage of the whole, due to the fact that the fall in temperature of the flame from entry to exit is only small. There is great danger, too, in the light ash which is formed, being carried forward to exercise its baneful effects as a flux on furnace linings, etc., and also its decolorizing effects on any glass with which it may come in contact. The waste heat from direct-fired furnaces may be utilized, say for steam raising, but only in a makeshift manner. Attempts, too, have been made to utilize this waste heat to pre-heat the air required for combustion, but owing to difficulties of furnace design these attempts are far from being successful. A fact often lost sight of in heating air by passing it through hot flues, is that the air is transparent to radiant heat and is only affected by actual contact with the hot walls of the flue. Thus preheating by passing air through hot flues of large cross-section is very ineffective. A great step in furnace work was the introduction of the Siemens regenerative furnace. Coal is burnt away from the furnace proper with the formation of carbon monoxide, which is delivered into the furnace together with air, and burns there to carbon dioxide. In addition, the waste hot gases leaving the furnace are made to pass through chambers filled with chequered brick work. By suitable means, the ingoing air and gas is afterwards passed through this hot brick work and so is heated before entering the furnace, resulting in an enormously increased temperature of combustion. In addition the regenerative chambers serve as filters for the dust or ash in the gases. In the Siemens producer the depth of fuel is large and there is considerable frictional resistance to movement of gas. The use of forced draughts causes the temperature to rise to such an extent as to cause clinkering. In order to keep down the temperature near the fire bars, steam is blown in, preventing clinkering, and also forming a mixture of carbon monoxide and hydrogen, the production of which is accompanied by an absorption of heat from the layer of hot coal near the fire bars. There are limits to the amount of steam that can be blown in; any excess results in the formation of carbon dioxide, or may even pass on into the furnace chamber unaltered, where it has the harmful effects of an inert gas. The best proportions of air and steam have to be determined by practice. Details were given of the Taylor producer, the Kerpely producer, and producers of the Mond type. The production of ammonia, low temperature regeneration, and the washing of producer gas by the Mond system were also discussed.—Note in *Jour. Soc. of Chem. Ind.* on an article by J. W. COBB in *Soc. Glass Tech.*

Ancient Saxon Remains

DURING excavations at Horncastle a short time ago a human skeleton was discovered. The bones were in a very good state of preservation, and indicated that the body had been buried on its back, at full length. By its side were a long sword, a large spear, and a smaller one, all of iron. These have just been purchased for the Municipal Museum at Hull. The remains are of Anglo-Saxon date, and were probably brought to this country by the Angles, and as these people came largely from Angle-land, in the district now known as Sleswick, the relics may be said to relate to an early Teutonic invasion of Lincolnshire. The sword is remarkable for its length, is double-edged, and, though naturally slightly corroded, is in a very fair state of preservation. Its total length is 33 inches, it is 1¾ inches in width, and it tapers at the top in order to accommodate the handle. Quite apart from the archaeological value of this collection, the sword is of particular value, as these weapons are very rarely found in Anglo-Saxon burials, though spears and other weapons are not uncommon. In his work on "The Industrial Arts of the Anglo-Saxons" Baron De Baye points out that the scarcity of swords is due to the fact that only individuals belonging to the upper classes were buried with this weapon, and that no doubt the swords were preserved as family treasures and left to heirs or friends.—*Nature.*

Stammering and the Evidence of Its Inheritance

By Ernest Tompkins

THE belief in the inheritance of stammering is founded largely on the statistical evidence. Denhardt's classical work deserves first attention on account of the influence it exerts. He says, Ueberhaupt darf es durchaus als Regel betrachtet werden, was ubrigens nach den voraufgegangenen Erörterungen niemanden befremden wird, dass die Eltern im Schosse der eigenen Häuslichkeit und namentlich heranwachsenden Kindern gegenuber gar nicht oder so wenig stottern, dass ein nachteiliger Einfluss auf die Sprache der Kinder von dieser Seite nur selten zu besorgen ist." In other words, parents hide their stammering from their children, so infection from the parents is practically nil. An alleged proof of the inheritance of tuberculosis which ignored the contagion of a case in the household, would properly be rejected on that score; and Denhardt's alleged proof of the inheritance of stammering should be rejected on the same basis. Parents may for a time hide such a trouble from the child, but they can seldom do so for long; and all Denhardt's efforts to explain away this defect in his statistics, instead of sufficing, indicates his own realization of the seriousnes of that defect.

The principle by which Denhardt thought he had proved the inheritance of stammering would prove measles inherited. When he encountered a stammerer he probed the stammerer's family history for four generations, and, finding another case of stammering in the line, he pronounced heredity proved in that line. In the case of measles, it would not be necessary to go back more than two generations to prove practically 100% inheritance by that method; but such procedure would be rejected as promptly for measles as it should be for stammering.

In this connection and in order to avoid misunderstanding it is necessary to observe that the German word "Stottern" is the equivalent of the English word "Stammering": both mean spasmodic abortive speech. The woeful confusion which has followed the attempt to appear Germanic by using the English word "Stuttering" to mean "Stammering" should be sufficient reproof for this unwarranted infraction of good sense and of the English language. See The Etymological Dictionary of the English Language, The Century Dictionary, and practically all competent authority.

Of the recent statistical proofs of the inheritance of stammering, the only one that even approaches the requirements of a proof is that of Dr. G. Hudson Makuen reported in his "Study of 1,000 Cases of Stammering." Notice that Dr. Makuen used the word "stammering with its proper meaning. Some other authorities to be quoted do not; but stammering is the subject of this discussion, and the word "stuttering" in those quotations is to be read stammering. To return to Dr. Makuen's statistical evidence of the inheritance of stammering, he finds it inherited; but lists so many other causes by percentage that heredity is forced out; giving us the anomaly of a proof of inheritance which on investigation develops into a proof of non-inheritance. See *Medical World*, Oct., 1916, Vol. XXXIV, No. 10, p. 379.

These statistical proofs of the inheritance of stammering are like the proofs of communication with departed spirits. When each proof is carefully investigated it is found to be fallacious; but when the fallacy is shown the advocates of the belief assure us that there are proofs which are not fallacious. Let them produce such a proof, and we will be convinced.

Prominent among the evidences of inheritance is the allegation of the beginning of stammering with the beginning of speech. Obviously, only a small proportion of the stammering could be coincident with speech acquisition, for the age of contraction, 3 to 7 (Chervin), is subsequent to the usual age of speech acquisition. When we come to investigate these few cases of "stammered always" we do not find an acceptable degree of accuracy in the records. Take for instance a recent family history which has been prominently called to public attention. The 1917 record of one individual in the case reads, "Robert, the elder son showed stammering in his first attempts to talk." The 1913 record of this same individual and by the same author says, "Robert, the elder by three years, was a stutterer from the age of two and a half years. The mother stated that he had no difficulty when he began to speak for about two years, when the impediment appeared rather suddenly." The early account states distinctly that the child did not stammer when he began to talk; yet within only four years another account appears and states distinctly that he "showed stammering in his first attempts to talk," and the latter statement is accepted by the press and the public as unassailable proof of the inheritance of stammering. The different accounts of two other individuals in this same case and by the same author are also illuminating. The 1917 history says, "William....also had two children, a boy and a girl, both of whom stammered quite severely from no apparent cause from the time when they first began to speak." The 1913 account says "William...also had several children, two of whom began to stutter before they were five years of age." If these two did not begin to talk until they were five, they certainly did not inherit the precocity of their grandfather, Robert, who talked at the age of six months! By such means are the "stammered-always" histories made.

That stammering does not occur with the beginning of speech may be shown in many ways other than by exposing the fallacies in the histories thereof. One way is an unavoidable consequence of a characteristic of the disorder. Stammering is intermittent; that is, normal speech alternates with abortive speech. If a child stammered from the time he began to talk, he must necessarily have acquired normal speech at once, instead of the long process which ordinary mortals require. Also, stammering is absent in solitude—the stammerer is fluent in solitude. Consider one of these remarkable children on the day it says its first word, and stammers, as is alleged. That child can retire to the solitude of its nursery and talk without difficulty! Do not smile. This is accepted for sober science in the year of our Lord 1917. The shame of it is, that by such superstition this chief speech defect is fostered and kept in existence to blight the lives of millions of innocent children yet unborn, not to mention the millions living who wish they were dead because of it.

Considerable of the belief in the inheritance of stammering is derived from the classification of the disorder. "Stammering is nervousness, and nervousness is inherited" is one of these stock arguments. In order to consider such arguments intelligently we must decide what stammering is. This would seem to be a Herculean task, for the existing views are legion, and new ones are constantly appearing. Fortunately, scientific procedure relieves us from difficulty and even responsibility in this case. We have no choice other than to accept the view which best satisfies the phenomena involved. There is only one view which is satisfactory. That is the view originally advanced (apparently) by Dr. Albert Liebmann of Berlin, altho, so far as we know, not fully developed by him. It is that stammering is conscious interference with speech prompted by fear of speech difficulty.

Let us prove the acceptability of the speech-interference theory by using it to explain the hitherto unaccounted-for phenomena of stammering. What are these phenomena? We will quote from authorities, so that no one can say we are selecting easy difficulties to explain. In one of Dr. Makuen's last articles (Some Recent Theories of the Treatment and Causation of Stammering, Medical Council, September, 1916) he said, "The problem of finding a causal factor which is common to all stammerers, therefore remains unsolved." Fletcher voices this same failure of the prevailing theories as follows, "Just how being bitten by a dog can produce stuttering in the same fashion in which habits are acquired is not easy to see........." In short, what explanation will harmonize such variant causes of stammering as imitation, association, fright, illness, injury, extreme exhaustion, and so on? We have Dr. Makuen's word, and Fletcher's intimation that no such explanation is extant. If it can be shown that there is such an explanation, then that explanation should have the attention which it deserves. The speech-interference theory does harmonize these variant causes, and in the following way. According to the theory the child's speech becomes automatic, and some accident or incident temporarily interrupts it sufficiently to induce the child to make a conscious effort to avoid the interruption. This effort is misdirected, for no one knows how he talks. The child closes its lips and holds them closed, or holds its breath, or expells its breath. Of course it can not talk under such conditions; and its failure to talk convinces it that it has an inherent speech difficulty, which it thenceforth endeavors to avoid by effort, thereby making the difficulty. Fright, injury, exhaustion, debilitating illness, and such causes, produce temporarily broken speech, which induces the child to begin the unfortunate conscious effort. In the case of contraction of stammering by imitation—another phenomenon never before explained—the child begins to interefere with its speech "for the fun of it," and so long as fear does not enter, the interference may be desisted from; but when the child fears it will contract the disorder it makes further conscious speech efforts under the impulse of that fear, and thereby makes its impediment. Every phenomenon of stammering is explained by this speech-interference theory, so those who make pretension to scientific procedure have no choice but to accept it. Now that we have a theory of stammering on which to consider the inheritance of stammering from the nature of the disorder, we may continue.

The argument that stammering is nervousness and therefore inheritable is found to be untenable, for the mechanism just described can not be classified as nervousness. No mental defect and no illogical idea are involved. The investigator who pronounces the poor stammerer illogical only condemns himself as irrational, for how could the stammerer be expected to see that his idea is mistaken when all the investigators from the beginning of speech to this time have been unable to see the mistake.

The argument that stammering is a disease of any sort, and therefore inheritable, also falls down. The contraction of a stammering by imitation has always negatived any disease theory. Even advocates of disease theories—Bluemel, for instance—are forced to admit the failure of those theories to account for the acquisition of stammering by imitation. Their claim that the stammering acquired by imitation is a special variety different from other stammering is palpably an effort to steer their theories past an insuperable obstacle. The disease views are negatived by other characteristics of the disorder. For instance, stammering disappears under hypnotic suggestion of ability to talk. This could not be the case if stammering were a disease. Also the disorder is free from complications such as accompany diseases—no headache, nausea, lassitude, fever, chill, and so on. If it were a disease, it would have to be a contagious one, for it is acquired by imitation; but contagious diseases always have a period of incubation, and are followed by immunity, whereas stammering often starts without any period that resembles incubation, and instead of being followed by immunity it is followed by the gravest danger of relapse. The stammering spasm is voluntary to the extent that the stammerer may desist from it; diseases are involuntary. Stammering increases in tenacity and intensity according to the extent of indulgence in it; and decreases to disappearance in childhood—with consistent non-indulgence, whereas diseases generally run a certain course. In many other ways the disorder shows itself not to be a disease, but a habit, altho an exceedingly tenacious one. Its tenacity is readily accounted for by the interlocking nature of its two elements, the mistaken idea of disability and the misdirected effort prompted by the mistaken idea, which in turn intensifies the idea of disability and prompts further misdirected effort. As Dr. Bryant has said with remarkable accuracy, "In fact the cause or causes may have long since passed away but the effects remain as more or less of a mental or physical habit, or both."

It has already been shown from the characteristic of intermittence that stammering can not occur coincidently with speech acquisition. That may also be shown from the nature of the disorder. Since stammering is interference with speech, stammering can not occur until after speech is acquired, otherwise there would be no speech with which to interfere.

Not only does the nature of the disorder remove all lesions, illogical ideas, and other defects on which inheritance has been predicated, but it gives positive evidence that inheritance can not occur. Since the fear of stammering is the continuing cause of the disorder, it could be transmitted from one generation to another only by the transmission of that fear. The fear is in connection with certain sounds, the sounds with which trouble has been experienced. But success with these sounds—and such success may occur when the stammerer is elated—removes the fear of them. In other words, the fear is not unchangeably associated with certain sounds. Every stammerer knows that; but it is seldom that a non-stammerer observes it as clearly as Fletcher has. He says, "The writers who hold that the consonants are the sources of difficulty for the stutterer have in many cases attempted to make out lists of such consonants. A study of such lists and several attempts to secure them from stutterers have led the writer to conclude that they are not the same for all stutterers, and that they do not remain constant for the individual stutterer." If the stammerer feared certain sounds invariably all his life, there would be some ground for believing that the fear might become sufficiently fixed to be transmitted to his offspring, in which case it would be the same fear; but Denhardt shows, with great elan in order to support his theories,

the well known fact that no two cases are alike, so we know that the fear changes from generation to generation, and it has just been shown that it varies within the generation: so we may safely say that it is not transmitted.

But, for the sake of the argument, let us assume that the particular fear of certain sounds necessary for the transmission of stammering, were transmitted. That fear could not continue, on account of the period of freedom from stammering during speech acquisition. We have already shown that the fear arises from difficulty experienced with those sounds; but the converse is true, that experiences of success with those sounds removes the fear, that is the principle of recovery—a principle so well demonstrated that it can not be gainsaid. The child's speech success during the period in which it was learning to talk would remove every vestige of inherited fear, even if that fear could be inherited, but we have already shown reasons for believing it could not; so the nature of the disorder affords two bars to its inheritance.

Now let us reflect and endeavor to see what has brought the public to its firm belief in the inheritance of stammering. It is impossible to prevent the dissemination of defective views, especially views which contain a considerable proportion of fact. Constructive criticism of those views would render them practically harmless. But we have no criticism worthy of the name in the field of stammering, and certainly no constructive criticism. Instead of a deep desire to relieve the stammerers and to elevate American science there has been too much desire to attract attention to individual ideas. Consequently, although much truth has been advanced—more than enough to extirpate the disorder and to bring relief to present sufferers—that truth is rendered valueless by a cloud of confusion kept alive by superstition ana persistent maintenance of individual ideas, the very contradictoriness of which inevitably invalidates most of them. While we have made some advancement in the ideas themselves—have abandoned the structural theories, and largely the organic theories, for psychic causes, we have failed to see what an obstacle to progress has been built up on inference from those vanishing theories. The idea that stammering was a disease of hereditary class, coupled with observation which did not take account of known causes of the disorder, has built up a belief in inheritance which in turn makes the impediment seem a disease, although we have already abandoned much of that view from consideration of the nature of the disorder itself. In order to get relief to the stammerers we must develop a criticism which will eliminate superstition and preserve the truth. The criticism should begin with the writer himself. If, however, he presents specious views trusting to the editor to suppress criticism, both he and the editor should be shown that the press should stand for the advancement of mankind, not particular individuals at the expense of mankind. The belief in the inheritance of stammering is only one of the monumental superstitions regarding the disorder which must be removed before we make substantial progress in that field.

Correspondence

[The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.]

Properties of Atomic Weights

To the Editor of the SCIENTIFIC AMERICAN SUPPLEMENT:

In Sir J. J. Thomson's last lecture on "The Electrical Properties of Gases" (SCIENTIFIC AMERICAN SUPPLEMENT of August 11, 1917), there appeared the following interesting conclusion:

"Taking hydrogen as a basis, it would be found that with very few exceptions the atomic weight was less than the nearest whole number. * * * It was known that mass was not constant, but depended on the amount of energy represented. * * * With the exception of silicon and chlorine, the mass of the atom was always just a little less than the sum of its constituents. This fact indicated that work must have been done in pushing the constituents together. The amount of this could be estimated by the difference between the atomic weight and the nearest whole number. The amount thus determined represented a greater amount of energy than had yet been found in the α particles emitted by radio-active bodies."

Interested in the discovery of this peculiar property of the atomic weights, I have tried to work out the figures and to determine whether there is any further relationship between the elements not developed in Sir J. J. Thomson's lecture. Accordingly I have converted the table of atomic weights (obtained from a recent textbook of chemistry) to an H basis by decreasing the amounts in the ratio of 1:1008. Arranging the elements in their order by weights, the following results were obtained for those with a weight of less than 100:

Element	Atomic Weight	Dec. Difference betw. Weight and next Whole Number	Ratio of Atomic Weight to Difference
H	1.00	...	...
He	3.96	.04	1.01%
Li	6.88	.12	1.74
Gl	8.93	.07	.78
B	10.91	.09	.82
C	11.90	.10	.84
N	13.90	.10	.72
O	15.87	.13	.82
F	18.85	.15	.79
Ne	20.04	.96	*
Na	22.82	.18	.79
Mg	24.13	.87	-
Al	26.88	.12	.45
Si	28.08	.92	*
P	30.79	.21	.68
S	31.81	.19	.60
Cl	35.17	.83	*
K	38.79	.21	.54
A	39.56	.44	1.11
Ca	39.75	.25	.63
Sc	43.75	.25	.57
Ti	47.72	.28	.59
V	50.59	.41	.81
Cr	51.58	.42	.81
Mn	54.49	.51	.93
Fe	55.40	.60	1.04
Ni	58.21	.79	1.35
Co	58.50	.50	.85
Cu	63.09	.91	1.44
Zn	63.99	1.01**	1.58
Ga	69.44	.56	.81
Ge	71.92	1.08**	1.50
As	74.36	.64	.81
Se	78.57	.43	.55
Br	79.28	.72	.91
Kr	81.26	.74	.91
Rb	84.77	.33	.39
Sr	86.90	1.10**	1.26
Y	88.29	.71	.80
Zr	89.88	1.12**	1.24
Cb	92.75	1.25**	1.35
Mo	95.23	.77	.81

*Abnormal.

**1.00 is added to make result agree more closely with normal.

The elements of greater weight than 100 are not listed because the variations are too large. It is probable that Thomson intended that his statement that "the atomic weight was less than the nearest whole number" should apply only to elements of less than 40 in atomic weight, as in the preceding discussion he had made this reservation, the weight for such elements being more accurately known. The rule does, indeed, hold good down to Mn, with a weight of 54.49—with four exceptions, two of which, silicon and chlorine, were mentioned by him. It is possible that the other two, neon and magnesium, would agree with the rule if the latest revised figures for their atomic weights should be used; and it is probable that the variations from normal for elements of greater weight would be reduced if more accurate figures were obtainable.

The table reveals a fact not mentioned by Thomson, and perhaps not yet discovered—namely, that the differences between the atomic weights and the next whole number increase progressively with the atomic weights themselves. To bring this out more clearly the third column of figures has been added, giving the ratio between the two amounts. While there is far from being a constant relationship, it is of interest to note that for nearly one-third of the elements given in the above list the ratio lies between 75% and 85%; and for one-half it lies between 60% and 93%. This can hardly be a matter of coincidence.

Assuming that this fact is not accidental and that further extension of the principle will be made possible by future revision of the atomic weights, we reach the conclusion that *there is some causal connection between the mass of an atom and the amount of work done to combine the constituents of that atom.* From this it is possible to derive the conclusion that, since the intra-atomic forces are known to be electrical in nature, and since these forces offset the mass of the atom by about 1%—or rather counteract the force of gravity by 1%—such inter-action implies the *electric nature of the force of gravitation.* Thomson has stated that the amount of energy bound up in the atom is greater than that revealed in the α particles emitted by radio-active bodies, and such energy is, of course, of a much higher order than that of gravitation. In stating that the intra-atomic energy offsets by about 1% the force of gravity it must be remembered, therefore, that we are dealing with the attraction between the earth and an atom, and not that between two individual atoms—the real measure of gravitational force being the latter rather than the former. It would, then, be proper to assume that gravitation is a very small residual effect due to the electrical forces within the atom, and that the 1% reduction in gravity is a secondary effect, due perhaps to interference, absorption, or some phenomena within the atom, corresponding to the effect of light waves upon molecules.

There are, of course, many theories as to the electrical nature of gravitation, the principal one being that it represents a residual attraction of opposite charges, greater than the repulsion of similar charges, in the ratio of $(1+10^{-n})$: 1 (W. Sutherland, *Phil. Mag.*, Dec., 1904). No tangible evidence of any connection between gravitation and electrical phenomena has ever been discovered, however, and it is probable that we must rely for some time on such proof as is afforded by relationships similar to the one discovered in respect to atomic weights.

OWEN ELY.

Head Resistance of Airplanes

To the Editor of the SCIENTIFIC AMERICAN SUPPLEMENT:

In the very interesting article in the SCIENTIFIC AMERICAN SUPPLEMENT, No. 2200, of March 2, A. C., page 130, "The Technical History of the Airplane," it is said that the first man who seems to have understood the importance of reduction of resistance was the late Edouard Nieuport, who in 1909 produced an aeroplane with a very fat (flat?) body which almost completely inclosed the pilot and succeeded in making a big improvement in speed on an aeroplane of comparative small power.

Since that day all modern aeroplanes have been inclosed as completely as the requirements of the pilot's view allows. This statement needs a correction.

The drawing, Fig. 1, in my U. S. Patent No. 710266, September 30, 1902, and the drawing, Fig. 2, in my U. S. Patent No. 730107, June 2, 1903, not only show an aeroplane which completely encloses the pilot but in all other respects shows the idea that the head resistance of the aeroplane should be as little as possible.

Copies of my patents were mailed at the time of their issue to the Aero Club de France in Paris and since *that* time the idea of as little head resistance as possible has been accepted.

Yours very truly,

THEOD. GIBON.

High Temperature Development of Roll-Film, Film-Plates, and Papers

IN the development, etc., of plates or films under tropical conditions, *i. e.*, where the solutions and washing water may be at a temperature as high as 95 degrees F. (35 degrees C.), the chief difficulty met with, apart from the actual melting of the swollen gelatin film, is reticulation. This is very easily produced with swollen gelatin by a change of temperature or by an osmotic change such as might be produced by transfer from a solution of one concentration to one of another, or by transfer to an acid solution. It is necessary therefore to keep all solutions at about the same temperature and also to avoid abnormal swelling of the gelatin during any part of the process. The latter may be achieved by (1) hardening before development, (2) hardening during development, or (3) temporary hardening during development and a permanent hardening afterwards. (1) The author obtained better results by the use of formalin than with alum or chrome alum, but with old films weak, foggy negatives were produced. (2) The method of Saal and others of using formalin in the developer, either with or without alcohol or acetone, was found to produce fog, and the use of alum or chrome alum in alkaline developers was of course impossible. (3) The author found this method most generally applicable. Addition of alcohol or acetone to the developer in sufficient quantity to reduce the water absorption appreciably was not possible with a celluloid base. The addition of large quantities of certain salts such as sodium sulphate or sulphite, with addition of bromide to reduce fog, is fairly efficient with most developers, but the best developer for the purpose was found to be:—*p*-aminophenol hydrochloride, 7 grms., sodium-sulphite, 50 grms., sodium carbonate, 50 grms, and water up to 1,000 c.c., which prevents swelling of the gelatin and develops quickly and cleanly. If the temperature does not exceed 75 degrees F. (24 degrees C.) no further hardening is necessary, the usual acid fixing bath being used; up to 85 degrees F. (29 degrees C.), a chrome alum hardening and fixing bath should be used and at higher temperatures a formalin hardening and fixing bath. This method is applicable to both plates and films; much fewer precautions are necessary with papers, the film of which is generally fairly hard, but it is preferable to use extra bromide in development, an acetic acid stop-bath, and a potash alum hardening and fixing bath.—From Com. No. 62 Kodak Research Laboratory, by J. I. CRABTREE.

The Fourth Dimension*

The Engineer's Playground

By R. Fleming

Is it worth while? Is the subject of the Fourth Dimension, or more correctly Four-Dimensional space, of sufficient importance to warrant attention from the engineer who has so many real things to occupy his thought? The answer is, only as a playground. He can well leave to the professional mathematician the severe mental effort necessary to be at home in the

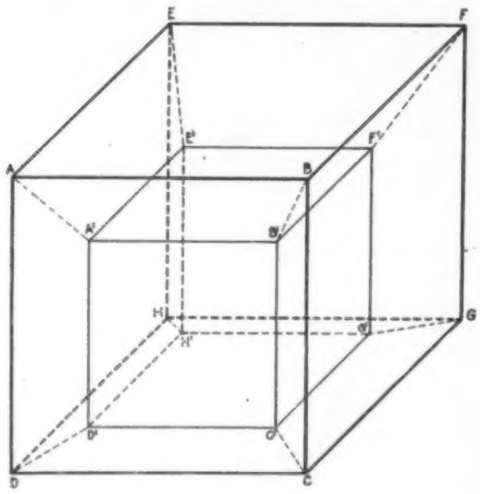

Figure 1.

regions of hyper-space. But as a playground the Fourth Dimension offers him a field for abstract logic unsurpassed in the whole realm of thought. Nowhere else can he obtain so great an amount of conjecture from so small an amount of fact.

Professor Bryan of the Royal Society, in his article, "The Popular Fallacy of 'the' Fourth Dimension," in the *Cornhill Magazine*, sarcastically writes: "There is a certain mystical concept, described as 'the Fourth Dimension,' which from time to time figures in magazines and popular journals containing articles of a semi-scientific character. This so-called Fourth Dimension appears to afford a certain fascination to some members of the professional and business classes, such as engineers, doctors, retired army officers of private means, and even millionaires who not infrequently spend their time in writing books or papers on the subject, sometimes publishing these at their own expense."

Professor Simon Newcomb, greatest of American astronomers, speaks and writes on the subject in quite a different spirit. He chose "The Philosophy of Hyperspace" as the subject of his presidential address before the American Mathematical Society. His article, "The Fairyland of Geometry," in *Harper's Monthly Magazine*, states: "We are told by philosophers that absolute certainty is unattainable in all ordinary human affairs, the only field in which it is reached being that of geometric demonstration. And yet geometry itself has its fairyland, a land in which the imagination, while adhering to the forms of the strictest demonstration, roams farther than it ever did in the dreams of Grimm or Andersen."

HISTORICAL

For 2,000 years Euclid held sway in the world of geometry until about 1830 when the Russian Lobachewsky and the Hungarian Bolyai independently brought forth a self-consistent geometry, based on the assumption that through a given point more than one straight line can be drawn parallel to a given straight line. In 1854 the German Riemann originated another geometry, self-consistent throughout, based on the assumption that through a given point no straight line can be drawn parallel to a given straight line. These non-Euclidian geometries attracted but little attention until the 60's and 70's, when the foundations of geometry were studied anew by mathematicians. The properties of a hypothetical four-dimensional space then began to be developed.

Fourth Dimension enthusiasts often quote Plato and Kant. But they read into the allegory of the Greek philosopher and into the thought of the mighty thinker meanings never intended by their authors. The words *quarta dimensio*—the "fourth dimension"—were first used by Henry More, an English philosopher of the Platonist school. In a book dated 1671, he assigns four dimensions to spirits.

IS THERE A FOURTH DIMENSION?

No, not with the meaning usually attached to the question. In our space, coordinates to three axes X, Y and Z, each axis at right angles to the other two, determine every point. Can there be a fourth axis, W, at right angles to each of the other three, thus creating a fourth dimension? Only as a mathematical conception can it be said that such a dimension exists. There is not the slightest evidence from the world of matter around us, the world of our experience, that space has more than three dimensions. Moreover, even if it existed a fourth dimension could not be recognized by a person knowing but three dimensions.

Attempts have been made to solve certain problems in chemistry and physics by the hypothesis of hyperspace, but full credence has not been given to the conclusions drawn. Hinton, who wrote much on four-dimensional space, believed that the phenomenon of an electric current could be explained by vibration in a fourth dimension. "A vortex with a surface as its axis affords a geometric image of a closed circuit, and there are rotations which by their polarity afford a possible definition of statical electricity." Professor Wilson of Harvard thinks it not improbable that the time is near when physicists, in addition to mathematicians, will have to become accustomed to the use of four dimensions.

VAGARIES REGARDING THE FOURTH DIMENSION

Lovers of the "occult" early seized upon the idea of a fourth dimension as the road by which spirits appear to three-dimensional man in dreams, apparitions and at the invocation of mediums. Spiritualism, telepathy, theosophy, clairvoyancy, have thus been "explained" by "the fourth dimension."

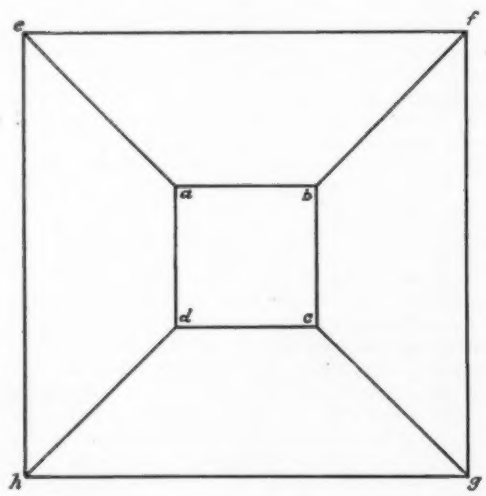

Figure 3.

It is unfortunate that the wide use of the words is largely due to modern spiritualism. The man to blame above all others is J. C. F. Zollner, professor of physical astronomy at Leipzig. During the years 1877 and 1878 the American medium, Slade, was in England and on the Continent performing his feats of slate writing, passing material bodies through each other, tying and untying knots in an endless cord, and generally mystifying the public. Zollner had more than 30 sittings with Slade and was confirmed in his belief that the world in which we live is contained in a four-dimensional space and that this higher space is the dwelling place of beings acting on the inhabitants of earth through a fourth dimension. At one of his sittings he "shook hands with a friend from the other world." Slade had been arrested and convicted in England for fraud but Zollner believed him to be condemned innocently—"a victim of his accuser's and his judge's limited knowledge." Zollner was a voluminous writer and his views were widely spread.

TIME AS A FOURTH DIMENSION

In the introductory chapter of "The Time Machine," a story of unusual interest by H. G. Wells, the philoso-

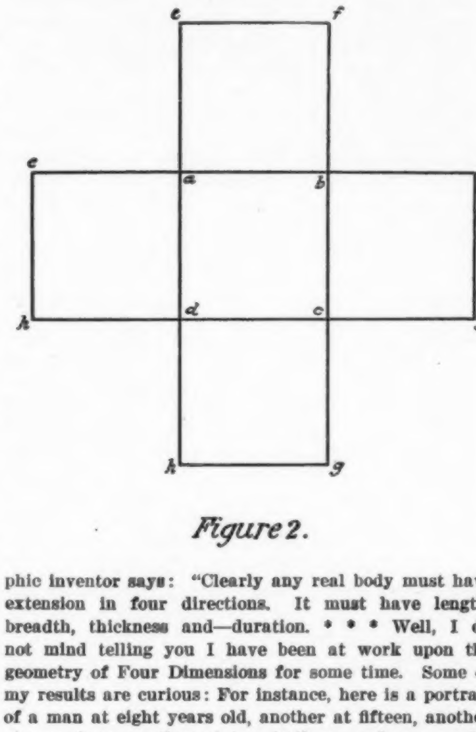

Figure 2.

phic inventor says: "Clearly any real body must have extension in four directions. It must have length, breadth, thickness and—duration. * * * Well, I do not mind telling you I have been at work upon the geometry of Four Dimensions for some time. Some of my results are curious: For instance, here is a portrait of a man at eight years old, another at fifteen, another at seventeen, another at twenty-three, and so on. All these are evidently sections, as it were, Three-Dimensional representations of his Four-Dimensional being, which is a fixed and unalterable thing." What the novelist uses to such advantage to adorn his tale has been considered seriously by other men. Henri Bergson, whom nowadays it is the fashion to quote, says in his "Time and Free Will": "Duration thus assumes the illusory form of a homogenous medium, and the connecting link between these two terms, space and duration, is simultaneity, which might be defined as the intersection of time and space." (Whatever this may mean!)

If a three dimensional body were to pass through a two-dimensional region the dweller therein could be cognizant only of successive sections which would appear as planes. In the same way if a four-dimensional body were to pass through three-space the dweller therein could be cognizant only of successive sections appearing as solids. Looking along the direction of time as a fourth dimension a man would observe a new three-dimensional body each successive instant of time. The aggregate of these sections possesses the property of a four-dimensional body—the cross section is a solid or three-dimensional figure.

Lagrange long ago defined mechanics as a geometry of four dimensions, time being one of the dimensions. Four variables, x, y, z and t, are required to locate a particle in both space and time.

THE REPRESENTATION OF FOURFOLD SPACE

It is impossible to form a mental picture of a direction at right angles to the three we already know. We cannot visualize a four-dimensional figure. We can, however, represent on a plane surface the boundaries of a hyper-solid. Following conventional methods, we assume a point A which, when moved in a fixed direction, generates a straight line, A B. The line A B moving at right angles to itself a distance equal to its length generates a square. The surface or square A B C D moved perpendicular to itself a distance equal to one of its edges generates a cube. It is noted that the line has one dimension; the square two dimensions at right angles to each other; the cube three, each at right angles to the other two. By analogy, if the cube is now moved in a fourth direction, at right

*From the *Journal* of the Cleveland Engineering Society.

angles to each of the other three, a distance equal to one of its edges, there is generated a tesseract, hyper-cube, cuboid, or C_8 as it is variously called. The initial cube A B C D E F G H moves along the mystical axis W a distance A B until it reaches the position A' B' C' D' E' F' G' H'. It also moves in a direction perpendicular to each of its six faces forming six other bonding cubes A B C D A' B' C' D', A B F E A' B' F' E', B F G C B' F' G' C', A E H D A' E' H' D', E F G H E' F' G' H' and D H G C D' H' G' C'. From the figure it is seen that the hyper-cube has 16 corners and is bounded by eight equal cubes, 24 equal planes or faces and 32 lines. Each corner is common to four edges, each edge is common to three faces and each face is common to two cubes.

As a conception of the hyper-cube, the simplest of hyper-solids, is so essential to further progress another method of presentation will be given. This is taken from *Science* (May 13, 1892). The difficulties to be overcome are considered analogous to those that an imaginary plane being, a being who has no conception of volume, would have in trying to understand a geometric solid. In his world as in ours a point moving in one direction traces a straight line and a line moving perpendicular to itself traces a square or rectangle. Beyond this he cannot proceed; for he has no knowledge of a third dimension. He can infer that a cube is generated by a square moving in a direction perpendicular to all of its sides and that each side traces a new square. He also infers that the moving square in its first and last positions forms two faces of the cube. By making a diagram (Fig. 2) he can count six faces, twelve edges and eight corners of the cube. But the corner *a* is represented as the generator of two lines *a e* which is evidently incorrect. The outer squares are therefore to be turned through 90° about their generating lines until the two lines *a e* merge into one, and the four spaces, *ee, ff, gg, hh*, disappear. He can suppose the central square to move away in the, to him, unknown direction, carrying with it the outer squares, which would then appear to sink into the center and disappear as they reached their generating lines until at last the lines *ef, fg, gh, he*, would reach the position now occupied by the sides of the square *a b c d* and become in the picture what they are really, the sides of the sixth square *e f g h*. Supposing, in the next place, that the square *a b c d* as it moves away is still visible but smaller by perspective, the plane being could draw a diagram (Fig. 3) which would represent to him the boundaries of the cube. To us it is a perspective view of the cube.

Let the three-dimension being proceed in the same way. A cube moving a distance equal to one of its edges in a direction perpendicular to all of its faces will generate the hyper-cube. Placing a cube on each face of the original cube, after the analogy of the plane being's squares, we have the six cubes shown in Fig. 4.

An eighth cube is represented by the outer faces of the six cubes. It is evident that the three lines marked *cC* are really one, the two faces *bc* are one face and so on. We may now imagine the central cube to move away in the fourth dimension, and the others to sink inward and disappear as they reach the present boundaries of the central cube, where they turn at a right angle into the new direction. Finally all the outer faces will meet as the boundaries of the eighth cube DF. Supposing the cubes elastic, we may stretch their outer faces and diminish the inner until we obtain a perspective view of the hyper-cube similar to Fig. 1.

The story "Flatland," by E. A. Abbott, should be read. It is supposed to be told by a dweller in two dimensions and well illustrates the limitations under which he lives. The reader's interest is sustained throughout and when the book is finished he is better able to develop relations between three-space and four-space.

The cross section of a solid or three-dimensional body is a plane, that of a four-dimensional body is a solid. In four-space, planes may be perpendicular to each other and meet only at a single point. Our knots would be only loops or coils in four-space and could be untied by carrying one loop out of our space and bringing it back in a different place. In the same way the links of a chain would fall apart. Solids that are symmetrical in three-space about a plane could be turned around in four-space and made to coincide. The left hand becomes the right hand, the same as in a looking glass. In four-space we may have five points each equidistant from the others. In two-space rotation is about a point, in three-space about a line and in four-space about a plane.

The imagination can run riot with the possibilities He could leave or enter a closed room without disturbing the walls. He could extract the treasures of any safe without opening the door. The contents of a bottle could be drained without removing the cork and of an egg without breaking the shell. The fourth-

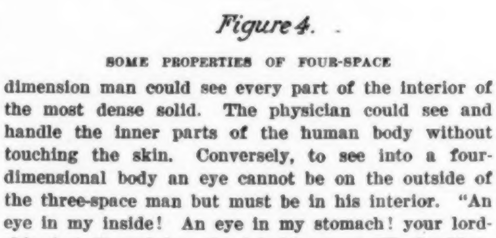

Figure 4.

SOME PROPERTIES OF FOUR-SPACE

dimension man could see every part of the interior of the most dense solid. The physician could see and handle the inner parts of the human body without touching the skin. Conversely, to see into a four-dimensional body an eye cannot be on the outside of the three-space man but must be in his interior. "An eye in my inside! An eye in my stomach! your lordship jests!" exclaims the inhabitant of "Flatland" to the stranger who is endeavoring to initiate him into the mysteries of a higher space than that to which he has been accustomed.

A point starting from the center of a sphere can move by way of the fourth dimension away from the sphere without approaching the surface. There are hyper-spheres and hyper-cones and the puzzling fourth-dimensional wheel and shaft. The first number of the *American Journal of Mathematics* begins with a proof by Professor Newcomb of the proposition: "If a fourth dimension were added to space, a closed material surface (or shell) could be turned inside out by simple flexure; without either stretching or tearing." A paper in a later volume describes the six regular hyper-solids bounded by equal regular polyhedrons found in four-space. But we are off the playground. Before returning, a few theorems will be quoted from Manning's "Geometry of Four Dimensions":

"The plane of three non-collinear points of a pentahedroid, if it does not itself lie in the hyperplane of one of the cells, intersects the pentahedroid in a convex polygon."

"Two successive rotations around two different axis-planes are together equivalent to a single rotation around an axis-plane, if the two axis-planes intersect in a line."

"Two conjugate series of isocline planes are isocline in opposite senses."

"In a simple polyhedroid the number of cells plus the number of edges is equal to the number of faces plus the number of vertices."

"Why stop at four dimensions?" the cynic may ask. It is not necessary. The Italian geometer Veronese has written a geometry of *n* dimensions. There are many other treatises, intelligible only to mathematicians, on the same subject.

THE CONCEPTION OF FOUR-SPACE

Hinton declares, "There is really no more difficulty in conceiving four-dimensional shapes, when we go about it in the right way, than in conceiving the idea of solid shapes, nor is there any mystery at all about it." The French mathematician Poincare writes, "Anyone who should dedicate his life to it could, perhaps, imagine the fourth dimension." The truth lies between these diverse opinions. The subject is not an easy one. Much patience is needed. Knowledge comes gradually. Paragraphs have to be read and re-read slowly and but few at a time.

Professor Sylvester tells in one of his mathematical papers how, as he was casting about in bed one night to discover some means of conveying an intelligent conception of his subject, there came of a sudden to his mental retina a chemico-graphical image which answered his purpose. Four-dimension solids can also be studied to excellent advantage while lying in bed. The walls of the room may be considered as trays upon which a hypercube can be built. A glimmer of light will often come "of a sudden" where all is dark.

It is well to get the viewpoint of several writers. For this purpose Manning's "The Fourth Dimension Simply Explained" is excellent. The book is a collection of 22 essays, all but one selected from 245 submitted in competition for a prize offered by the *Scientific American* for the best popular essay on the subject. The introduction and editorial notes are by Professor Manning.

Attention is also called to "The Fourth Dimension," by Hermann Schubert in his "Mathematical Essays and Recreations." Though written for "cultured people who have not had a technical mathematical training," it contains as much mathematics as the average engineer will care to read.

The real student will find ample literature on the subject. The "Bibliography of Non-Euclidean Geometry, Including the Theory of Parallels, the Foundations of Geometry, and Space of *n* Dimensions," by Professor Sommerville, of St. Andrews, Scotland, is a book of 400 pages. About 1,800 of the references are made to books and articles, largely in languages other than English, on geometry of *n* dimensions.

The Gas Attack and Liquid Fire in Modern Warfare

The degree to which chemistry has entered into modern warfare is indicated by the use of poisonous gases. The Hague Convention prohibited the use of this infernal instrument, but, nevertheless, it has become a weapon of offense and defense horrible beyond description.

According to the *Journal of Laboratory and Clinical Medicine*, October, 1917, the toxic gases at present employed include hydrocyanic acid, arsenide of hydrogen, hydrogen sulphide and hydrogen phosphide, which are directly and immediately poisonous. A second group includes chlorine, carbon oxychloride, known as phosgene, and various other substances whose effects are to produce death by asphyxiation. A third class is not actually poisonous, but serves to cause the victims to retire from action because of intense lachrymation. Among these agents are chloracetone, bromacetone and iodacetone.

A knowledge of the chemistry and physics of gases is essential for their successful employment. Whether used in waves, in hand grenades, or in shells, climatic conditions and their physical nature determine their effectiveness. The wind must be moderate and blowing towards the enemies' lines at a rate of approximately thirteen miles an hour. A humidity of forty to sixty per cent adds to the certainty of a successful attack.

To recognize the approach of a chlorine gas wave, strips of blue litmus paper are placed in front of the trenches; a change of their color to red gives the signal of the approach of chlorine.

Efforts at counteracting the malign effects of a gas wave collectively have not achieved satisfactory results and dependence is therefore placed upon the gas mask.

The forms, shapes and devices thus far utilized in the manufacture of gas masks vary among the different armies, but the underlying principle is the same. Layers of gauze cover the mouth and nose, after having been impregnated with a neutralizing solution consisting of water, hyposulphite of soda and carbonate of soda. The protection thus afforded lasts for four hours when the gas is diluted to one in one thousand. The mask lacks protective value against carbon monoxide.

The use of liquid fire, incandescent gasoline or flaming phosphorus, is so deadly that protection along ordinary lines is without result.

It is a sad commentary upon the diabolic instrumentalities of war that the chemical industry, which has been of such constructive value in advancing human welfare, should become transformed into a hideous messenger of death against which chemistry is a weak defender.

The training which medical men are undergoing in order to familiarize themselves with the action of poisonous gases and the methods of treating those who have suffered from the fumes, has not held any line of treatment that is fraught with certainty or hope. The initial irritations of the bronchial tract and the profound alterations of the circulatory system are scarcely amenable to specific treatment, and dependence must be placed upon symptomatic therapeutics.

The use of poisonous gases is not to be condoned by saying "this is war." The rights of combatants have always received some degree of consideration in order to preserve the semblance of humanity in war's glorious art. Cruelty, hate, venom and hellish activities have been liberated in spite of the Hague Convention. Some of the triumphs of chemistry in warfare represent the defeat of civilization. The gas attack is but another unfortunate perversion of the potentially beneficent function of chemical science.—*American Medicine.*

The Treatment of Severe Burns with Ambrine*

A New and Radical Treatment of Great Promise

By Charles G. McMullen, M.D.

The letters by Miss Edith May, published in the *Outlook*, August 2, 1916, excited a somewhat skeptical interest in the use of ambrine as practiced by Dr. Berthe de Sandford at Issy-les-Moulineaux in France. The caustic editorial of Dr. Simmons in the *Journal of the A. M. A.*, August 12th still further confirmed my skepticism. In February, 1917, at the meeting of the Third Conference of Physicians, Department of Labor and Industry at Harrisburg, Pa., after hearing Dr. Sherman's paper on the Carrell-Dakin technique, in the discussion of which paper Dr. Sherman made some very commendatory remarks about the ambrine treatment, my real interest in the subject was aroused. The atomizer and apparatus necessary to carry out the technique were purchased at Philadelphia, and a supply of ambrine was secured through the efforts of Mr. A. L. Rohrer of the General Electric Company.

I had under treatment, at this time, a patient who had been very extensively burned about the face and hands by a hydrogen gas explosion, and more deeply burned about both thighs and legs from the ignition of his clothing. He had been under treatment since February 5, 1917. The burned tissues of the legs were sloughing and he was having considerable constitutional disturbances as the result of absorption. Large boric packs were used until the sloughs had separated, which took place on the 21st, sixteen days after the burn was received.

At this time the use of ambrine was begun. The patient was somewhat skeptical about "experiments," and hesitated about having us use the new treatment. After the first application of ambrine, he was fully converted, and the comfort experienced while wearing the dressing and the absence of suffering while the dressing was being changed was exceedingly gratifying to both patient and myself.

I expected of course that several operations of skin grafting would be necessary in order to cover such extensive surfaces. The very remarkable advance of epithelium and the small autografts developing from time to time, which also developed with the same rapidity, obviated the necessity of grafting. The daily dressings were continued, until May 30th, when the patient was discharged from the hospital. Ambrine or similar paraffin dressings are infinitely superior, as regards the comfort of the patient, to any method of treating burns known to the writer.

Its remarkable efficacy as regards rapidity of growth of newly formed epithelium is, I believe, due to the fact that this dressing does not in any way interfere with the delicate layer of advancing epithelium.

The granulations never become exuberant; therefore it is never necessary to use escharotics to destroy them.

The period of convalescence is shortened one-third to one-half, and the scar tissue is unusually soft and pliable and, as yet, this case has shown no tendency to contractures.

Regarding the technique, the first coat of ambrine is best applied with an atomizer, even a soft camel's hair brush is somewhat painful. An atomizer with a hand bulb is not satisfactory, however. An electric compressed air apparatus obviates this difficulty.

The ordinary absorbent cotton teased out in thin bits and applied was found to be much better than sheet cotton. The dressing must be changed each day.

A résumé of the literature prepared by Helen R. Hosmer, of the Research Laboratory of the General Electric Company, is appended.

APPENDIX

LITERATURE ON THE PARAFFIN TREATMENT OF BURNS

Reference[1] gives a brief general account by the correspondent of the *Medical Record* of Paris on the efficacy of ambrine treatment of the terrible burns caused by liquid fire from shells. A hospital of 150 beds for the treatment of such burns has been established at Issy-les-Moulineaux, just outside of Paris, under the charge of Dr. Berthe de Sandford, the originator of the ambrine treatment in France. The substance was originally devised as a treatment for rheumatism, but application in an emergency to extensive burns gave such good results that Dr. Sandford was led to advocate its use even in the face of much indifference from his colleagues.

Hull[2] has investigated the ambrine treatment for burns and believes that it produces singular rapidity of healing in slight burns and improved results in bad burns.

"Observations carried out in a military hospital gave one the impression that the treatment was valuable. Burns healed with rapidity; constitutional symptoms rapidly abated; pain was reduced to a minimum; scarring appeared to be obviated, or at any rate was not apparent. The need for grafting large burns appeared to be avoided. * * * The patients were singularly free from sepsis. * * * Observers who had large experience of burns treated by picric acid, ointments, and other methods in ordinary use, were unanimously of the opinion that the paraffin method was superior to the older methods. The experience of those who had witnessed the results of burns after liquid fire attacks was that the ambrine treatment would save many lives and accelerate the recovery of all burns."

He attributes its efficacy to mechanical factors; protection from air, prevention of damage to newly formed granulations, keeping the tissues immobile by the splint-like effect of the wax, and the heat of application encouraging the flow of blood and lymph to the new capillaries.

By laboratory experiments he found that heating a suitable paraffin to 130 deg. C. with superheated steam lowered its melting point two degrees and made it mobile and workable. The results obtained by the use of such paraffin were indistinguishable from those obtained with ambrine. But addition of antiseptics and stimulating substances was always found to give great help in cleaning up the wound, etc.

He prepared a formula, known as No. 7 Paraffin, which gives excellent results, better than ambrine, healing severe burns without cicatrices or extensive scarring. This consists of:

Resorcin	1 per cent.
Eucalyptus oil	2 per cent.
Olive oil	5 per cent.
Paraffin molle (soft)	25 per cent.
Paraffin durum (hard)	67 per cent.

The resorcin may be reduced to 0.25 per cent., or 0.25 per cent. of betanaphthol may be used instead.

Hall uses the paraffin for the first dressing, sometimes replacing after two days, for two days with hot boric fomentations. The burn is first washed with sterile water, and dried, preferably with an electric blower. Without interfering in any way with blisters, it is then covered with wax at 50 deg. C., applied with a brush, sterilized in wax, or in very painful cases with a metal spray. A very thin layer of cotton wool comes next and is covered with a second layer of paraffin, more wool and a bandage. The dressing is changed daily, until the pus formation is small, and then every two days. Dead skin layers are removed at the second dressing. Sloughs usually separate after a few dressings.

"The results obtained by the use of No. 7 Paraffin have surpassed the results obtained by ambrine or any other tried preparation. Severe burns of the third degree, accompanied by sloughing, and in a very septic condition, have cleaned and taken on healthy repair under this treatment. Severe burns of both palmar and dorsal surfaces of the hands, extending to the tendon sheaths, have healed in three weeks without contracting cicatrices."

* * *

"The treatment is practically painless and patients rarely complain of pain after the first application. It has never been found in the least necessary to give an anesthetic for the first or subsequent dressings. The rapidity of healing, the absence of sepsis or pain, the healthy new skin resulting without contracting cicatrices or deformity, have been really remarkable. Burns come clean more rapidly than under ambrine treatment. Sloughs of deep tissues, in some cases down to bone, readily separate, and the burns become clean."

Matas[3] explains the lack of interest shown by the medical profession in the use of ambrine by the fact that its originator has allowed it to be exploited as a proprietary product and has kept its composition secret at a time of so great a crisis. His personal experience has confirmed the favorable reports of others. The history of the discovery of ambrine given in reference (1) is repeated and Hull's article describing the beneficial action of the ambrine treatment is quoted almost in full.

Matas has prepared Hull's formula No. 7 Paraffin containing betanaphthol, of which the cost is less than 18 cents a pound against $5.00 a pound for ambrine.

Experience with the paraffin treatment in some ten cases has been very favorable. It is easily applied at 100 deg. F. by means of a cotton mop for the first layer and a brush for the subsequent layers, of which there should be several in the more movable regions. Drying by gentle mopping and exposure to the air is sufficient. The mixture is soothing and pain ceases immediately in every type of burn and the relief continues while the wax was in place. The favorable observations of others are repeated.

Dowd[4] gives clinical details of several bad burns treated to show comparative results for paraffin and other dressings. He used a mixture of

Paraffin	2 parts
Vaseline	2 parts

Stearic acid 1 part, which melted at 112 deg. F. (44 deg. C.).

Other cases where ambrine was used were mentioned in discussion. The dressings were very painful and there was little or no evidence of superiority in the treatment.

Haworth[5] (Western Pennsylvania Hospital) recommends for the treatment of severe burns or other wounds that fail to epitheliate, the application of a wax made up as follows:

Paraffin (Gulf Ref. Co., Pittsburgh)	7.0 gm.
Liquid petrolatum, U.S.P.	3.0 cc.
White beeswax	10.0 gm.
Rosin	7.0
Resorcin	0.2
Sudan III	0.05
Alcohol (95 per cent.)	10.0 cc.

Other ingredients desirable for special cases may be added. Directions for mixing are given.

Reference[6] gives the formula of Parresine, a mixture said to have the same properties as ambrine, as follows:

Paraffin (M.P. 48-49 deg. C.)	94-96 per cent.
Gum elemi	0.20-0.25
Japan wax	0.40-0.50
Asphalt	0.20-0.25
Eucalyptol	2.00

Alkannin and gentian violet to color.

This is prepared by the Abbott Laboratories, Chicago. (No patent. Trade mark applied for.)

Leech[7] gives the brief history of ambrine and describes the appearance of the three similar preparations, Hyper-thermine, Parresine and Mulene.

Ambrine has about the following composition:

Paraffin	97.0
Fatty oil (sesame?)	1.5
Asphalt-like body	0.5
Coloring matter and undetermined	1.0

Mulene appears to contain paraffin, beeswax, a fat-soluble red dye and considerable rosin.

Leech gives directions for making a mixture of:

Paraffin (M.P. by U.S.P. method 47.2 deg. C.)	97.5 g.
Asphalt	from 3-5 drops
Olive oil	1.5 cc.

This closely resembles paraffin, melts at 45.4 deg. C., is very pliable and strong at 38 deg. C., adheres exceedingly well to the skin and detaches easily. The cost of materials is about 10 cents a pound.

Leech has examined and determined the properties of 25 different brands of paraffin and of the proprietary products similar to ambrine. The values are given. He concludes that nearly all have properties that would make them useful. Several appear superior to ambrine and it probably could be substituted for it. Such are:

*From *The General Electric Review*. - Sept. 1917.

[1]Medical Record, 91, 160-1, Jan. 27, 1917.

[2]Hull, (Roy. Army Med. Corps) British Medical Journal, Jan. 13, 1917. Canadian Practitioner and Review, 42, 169-73, April, 1917. Abs. Jl. Amer. Med. Assoc. 68, 873, 1917.

[3]Matas, New Orleans Medical Journal, 69, 677-88, 1917.

[4]Dowd, Annals of Surgery, 65, 781-5, 1917.

[5]Haworth, Journal Amer. Med. Assoc. 68, 1404, May 12, 1917.

[6]Journal Amer. Med. Assoc. 68, 1406, May 12, 1917.

[7]Leech, Journal Amer. Med. Assoc. 68, 1497-1500, 1917.

"Paraffin 118-120 F.," Standard Oil Co. of Indiana.
"Paraffin 120-122 F.," Standard Oil Co. of Indiana.
"Paraffin No. 9," Waverly Oil Works, Pittsburgh.
"Hard paraffin," Robert Stevenson & Co., Chicago.
"Paraffin 118-121 F.," The Atlantic Refining Co., Phila.

Sollmann[8] has studied the physical properties of a series of paraffin mixtures designed for use in the place of ambrine and the other similar proprietary products now appearing. He has formulated the important properties as: melting point between 48 and 53 deg. C., hardness, ductility, and pliability, and he has devised simple measures for the last three which he explains quite fully. He gives a table of the properties of 28 substances, none containing more than two constituents, of the following classes:

I. Paraffin
II. Paraffin-wax
III. Paraffin-asphaltum
IV. Paraffin-oil
V. Paraffin-petrolatum.

The commercial paraffins, melting between 48 and 53 deg. C., are quite similar to ambrine, possibly a little more fragile. The addition of small quantities of wax modifies the properties very little. The proprietary products, ambrine, Mulene and Parresine are of this class and approach very closely in properties to the simple paraffins. The last named is softer and more fragile than ambrine. The paraffin-asphaltum mixtures are distinctly more pliable, adhesive and capable of forming thinner layers but do not form perfect mixtures. Paraffin-oil combinations are considerably softer and weaker than the paraffins. The paraffin-petrolatum mixtures are very soft, greasy and crumble easily.

Tests of their behavior on application to the skin showed that the three proprietary mixtures mentioned and some nine of the other mixtures did not differ essentially from the simple paraffins.

Sollmann[9] continues his experimental studies of the paraffin treatment of burns and other open wounds by considering the effect and value of the various constituents upon the physical properties and reporting clinical results.

Simple paraffin will accomplish all that any of the mixtures can do. Admixture of other waxes produces no improvement except that asphalt does increase adherence a little. Rosin and most of the waxes tried raise the melting point. The effect of the addition of some fourteen different oils, etc., is given, but none produces significant improvement.

Certain paraffins are very superior to others. The choice should be those which are liquid at or below 50 deg. C. and the thin film should be pliable at 28 deg. C. and ductile at 31 deg. C. Such are easily produced. Addition of antiseptics is of no effect as only an infinitesimal quantity reaches the surface.

Sollmann finds that the application of the first coat is apt to be painful, and avoids the difficulty by preceding it with a coat of liquid petrolatum, applied with an oil atomizer. To this may be added any medication desired. The author is working out a series of solutions for this purpose. A film of cotton and the paraffin coating are next applied in the usual way.

Sollmann states that almost all surgeons who have used the paraffin treatment are more or less enthusiastic as to its advantages over the older methods of treatment. As it is particularly desirable at this time to get a correct estimate of its value as soon as possible, he proposes a number of methods of comparing its efficacy with that of other methods. He also suggests a number of substances, local anesthetics, antiseptics, epithelial agents, etc., that should be tested out in conjunction with the use of the initial coating of petrolatum.

Beiter[10] (of the United Alloy Steel Corporation) has used the paraffin mixtures with various oils, antiseptics, etc., on over 4,000 dressings of burns and lacerated wounds. In the absence of any observed advantage these mixtures were discarded in favor of the commercial Paraffin "Parrowax." The method of application proposed by Sollmann was found preferable to direct application by brush, especially by the patient.

Beiter seems to find the chief advantage of the paraffin to arise from the fact that the granulating surface does does not grow into or adhere to it as it does into gauze, and consequently is not destroyed at redressing. This very much increases the rate of epithelization and the comfort of the patient. The method produces quicker healing of superficial burns than any other familiar to the author. It does not, however, shorten the time of healing nor decrease the scar tissue formed in deep burns. The comfort at dressing is much greater than with any other treatment. The firmness, rigidity and smoothness of the covering is also conducive to comfort at other times. Also, when properly applied, it is cleaner than any other dressing because the discharges are confined, do not soil the linen, and produce no unpleasant odor.

The paraffin dressing is inexpensive, a pound of wax and a pint of liquid petrolatum together costing about 65 cents and being sufficient for many burns. It replaces the rather expensive gauze. It is, however, time consuming.

Hudson,[11] after mentioning the fact that the early skepticism of physicians concerning the ambrine treatment of burns was due to the fact that the substance recently made its appearance in France as a patent medicine applicable to rheumatism and other ailments, describes a spraying apparatus which he had to devise and make for his own use. The mixture has to be kept between 50 and 70 deg. C. during application, and this necessitates the use of an electric heater for the air used in order to avoid solidification in the nozzle. An illustration and dimensions are given.

The apparatus, which is not patented, works perfectly and with a 10-lb. air pressure and a hole in the nozzle the size of a No. 47 drill an area of one square foot can be covered in about two seconds, a great advantage in extensive burns. A smaller hole may be better for ordinary use. The container should hold about two pounds of melted ambrine.

It is necessary to have a good volume of air as from a compressed air tank or an electrically operated automobile pump such as the "Lectroflator." The latter must have a safety valve to keep the pressure down. Hand bulbs and small pumping machines are not satisfactory.

The few cases in which the treatment has been tried indicate considerable good in the method, though it may be advisable to give a preliminary cleansing of the wound as by wet dressings of Dakin's solution for a day or two.

Application is not painful if the ambrine be kept below 70 deg. C. and redressing is easy, rapid and painless.

[8]Sollmann, Journal Amer. Med. Assoc. 68, 1037-41, 1917.
[9]Sollmann, Journal Amer. Med. Assoc. 68, 1799-1801, June 16, 1917.
[10]Beiter, Journal Amer. Med. Assoc. 68, 1801-2, June 16, 1917.
[11]Hudson, Med. Dir. N. Y. Medical Journal, 105, 301-2, 1917. H. I. du Pont de Nemours Co., Medical Record, Jan. 27, 1917, p. 160. Southern Medical Journal, Dec., 1916.

Kerguelen Island as an Antarctic Reserve

Extinction of some of the most interesting Antarctic species could be prevented by the turning of the Kerguelen islands into an immense reserve. A prominent French scientist, A. Menegaux, gives the following points about the fauna and flora of the islands, and concludes that an Antarctic reserve could thus be established with great utility to science.

The Kerguelen islands are situated on the border of the Antarctic regions at south latitude 48 degrees and east longitude 67 degrees, and lie at the south of the Indian Ocean. The largest island is about eighty by seventy-five miles long and has about the same size as Corsica. There are no permanent inhabitants in these islands. One of the most recent expeditions to this region was made within recent years by Lieut. Loranchet, and he drew up a very good map of the coast line of the main island. According to him, the most interesting specimens on this island are the birds. Out of 32 species noted by him, 21 build nests in the island, but there are only three species that remain all the year round and are special to the islands. One of these is the little *Chionis minor* whose habits and movements are so curious and which exercises great skill in detaching mussels and other shell fish from the rocks. Then come the warty cormorant (*Phalacrocorax verrucosus*), which is distinguished from the Antarctic species by the absence of the white spot on the back, also the Eaton duck (*Dafilula eatoni*), which lives on sea wrack and plant seeds. Although this bird has been known to lay six eggs, it is noteworthy that most of the birds lay only one egg because of the limited food resources of the island, and a good case of adaptation is shown here. Other sea birds abound including penguins; the albatros, petrel, etc., among which is the Giant Petrel or "bone breaker" *Macronectes giganteus*, which is such a voracious eater that it is obliged to eject part of its food before it is able to fly. Sea animals are represented by cetaceous mammals, and especially the enormous sea elephant, *Macrorhinus leoninus*—a species which it is desired to preserve—whose length reaches 17 feet. These animals come on shore for reproduction. He cites also the sea leopards and the Weddell seal, this latter being the variety which advances the farthest to the south. The fur seal has disappeared long ago, being exterminated by hunters. The author does not mention any other land animals except the rabbits brought by different expeditions and which now cover the whole island, also an abundance of rats from the same source. As to whether the island has the proper climatic conditions and vegetation to make it habitable (the small islands are negligible) he concludes in the negative, and states that this region has a "sea climate" with but small annual variations. The coldest months correspond to our summer (14 degrees C. in the daytime and eight degrees at night), and the warmest, to our winter (19 degrees and one degree), so that the island has a cold but not a freezing climate. But what makes this region disagreeable is the violence of the west wind and the frequent storms as well as the continual gray and lead colored sky, not to speak of the extreme abundance of rain, for it rains twenty-one to twenty-nine days in the month. The island is of volcanic origin and has a broken surface, with some rather high mountains such as Mt. Ross (6,600 feet), and Mt. Richard (4,130 feet), and glaciers abound at the higher altitudes. Vegetation is stunted upon the rain-washed basalt ledges, and above 300 feet altitude there remain only moss and lichens. On the lower levels he found only 15 plants and four species of ferns, while reeds grow about the shores and some grain plants are observed, but these never cover large areas. The most remarkable plant on the islands is the "Kerguelen cabbage" which has marked antiscorbutic properties. But the rabbits on the main island have eaten it off entirely and it is only seen on the small islands. There are no trees or even bushes so that combustibles are entirely lacking, with the exception of lignite beds, which are very hard to work. On the whole, the author thinks that little could be done with the island from a colonial or a commercial standpoint in spite of its large size, good harbors and its situation on the steamer line between Australia and South Africa. He recommends that it be set apart for the preservation of Antarctic birds and mammals, and especially for the sea elephant, for in fact the Kerguelen region is one of the last places of refuge where these remarkable animals can rear their young undisturbed, but they are doomed to disappear if hunted much longer, for each specimen can furnish 1,500 pounds of oil, and hence they attract hunters. For instance in 1910 as much as 5,000 tons of oil were thus produced on the island. Steps should therefore be taken by the French government to preserve the Antarctic sea elephant from destruction, and also to preserve the sea leopards and different cetaceous animals and perhaps the last of the Antarctic fur seals as well as the species of birds above mentioned. All destruction of animals should be forbidden and the hunters expelled. Should these measures be carried out, France will be the first country to establish an Antarctic zoological and botanical reserve. This will be of great value to science in preventing the extinction of certain species and is in line with the opinion which prevails in scientific circles that the proper measures should be taken to prevent the extinction of animal species before it is too late.

Potato "Butter"

The Ministry of Food states that in view of the shortage of butter they have been carrying out experiments in order to find suitable and economical ways of eking out the available butter and margarine supplies by mixing in other food substances and so producing cheap and palatable substitutes. These experiments have shown that an excellent "potato butter," costing only about 5d. per pound (or less if margarine is used), can easily be made in any household without special knowledge or apparatus in accordance with the following recipe:

Peel the potatoes and boil (or steam) until they fall to pieces and become flowery. Rub through a fine sieve into a large basin which has been previously warmed. To every 14 ounces of mashed potato add 2 ounces of butter or margarine and one teaspoonful of salt. Stir thoroughly with the back of a wooden spoon until the whole is quite smooth. The butter may then be made up into pounds or half-pounds and kept in a cool place.

The potato butter may be improved in appearance by the addition of a few drops of butter coloring, and if it is to be kept for more than a few days butter preservative of which there are several forms on the market, should be used. The amount should be in accordance with the printed instructions on the packet for use in butter. Both the coloring and the preservative should be well mixed into the potato at the same time as the butter and salt. If these directions are carefully followed potato butter will keep for a considerable time, though it may be found that the surface is apt to become dry, but this can be obviated by keeping it wrapped in grease-proof paper.—*English Mechanic.*

Stellar Dynamics and Statistical Mechanics

The five papers referred to below do not form a logical sequence of discussion, but are related to one another in that they are all more or less directly concerned with the methods of statistical mechanics and their applications to the problems of stellar dynamics. Since the positions and motions of individual stars are known only in a few instances, it is impossible to treat the motions of stars by the ordinary methods of classical mechanics, so that statistical methods have to be adopted. Important investigations in stellar dynamics have been made recently on this basis by several investigators, more particularly by Eddington and Jeans. There are two fundamentally different methods of treatment: (*a*) The stars may be compared with the molecules of a gas, and the effect of the various encounters considered, the discussion proceeding along the lines of gas theory. (*b*) It may be supposed that the encounters of stars have but small effect, so that the stars may be regarded as describing orbits under the general attraction of the stellar system as a whole, the discussion then proceeding along the lines of hydrodynamics. Both methods may be expected to give results of value for the general theory.

Prof. Charlier has adopted the first of these two methods in (1), and has worked out a kinetic theory for the stars based upon Newton's inverse square law of attraction; in gas theory the treatment has usually supposed either that the molecules are elastic spheres or that they repel each other inversely as the fifth power of the distance. The latter law is artificial, but was used by Maxwell because it introduced considerable simplification into the discussion. Where stars are concerned it is necessary to distinguish between real collisions and encounters. The latter occur when two stars approach one another sufficiently closely to produce a relative change in path without actually colliding. The number of collisions will naturally be considerably less than that of the encounters. The fundamental general equation of statistical mechanics is formed, and the effect of the collisions and encounters obtained. The discussion follows closely along normal lines. The integration of the fundamental equation when the solution is a frequency-function of type A is performed, the solution being rather more complicated than for Maxwell's law of repulsion. The time of relaxation, which is a measure of the time taken by the system to reach a steady state, is found to be about 10^{18} years. Jeans had previously obtained, by somewhat different reasoning, a value of 10^{16} years, which is of the same order of magnitude.

In (2) some of the results obtained in (1) are applied to prove the law of equipartition of energy for the stars. The proof is elementary and applies only for translational velocities, any possible energy of rotation not being taken into account. As regards translational energy, recent results indicate that the most massive stars have the slowest velocities on the average, and *vice versa*, which is in the sense required by equipartition. But whether there is anything like real equipartition, even for translational velocities, we do not know; still less do we know to what extent the energy of rotation shares in the equipartition. In any case, we should not expect equipartition to hold unless the system had practically reached a steady state, and other evidence must be adduced to settle this point.

In (3) the hydrodynamical analogy is used, the average motion of a small group of stars under the general attraction of the stellar system being considered, neglecting the effects of encounters and collisions on the motion of individual stars. The equation of motion for a steady state is derived from (1) and integrated. The result is obtained that in a star cluster, in which the stars are symmetrically distributed about an axis, in which there is hydrodynamical equilibrium and ellipsoidal velocity surfaces, these surfaces must be spheroids with their axes of rotation perpendicular to the radius vector from the center of the cluster. The same result had previously been obtained otherwise by Jeans. It was proved by Schwarzschild that the velocity surfaces are approximately spheroids with their rotation axes directed towards the *vertex*. Jeans, through insufficient evidence, had concluded that this direction was not perpendicular to the radius vector. On the other hand, Prof. Charlier, on the evidence afforded by recent investigations at Lund, concludes that the two directions are perpendicular. Jeans has since accepted the evidence on which Prof. Charlier bases this conclusion. The result supports, but does not prove, the supposition that our stellar system is in such equilibrium, for there are other factors to be taken into consideration.

In (4) Prof. Charlier discusses and compares what he calls the monistic and dualistic conceptions of the stellar universe. According to the former, the universe can be considered as a single system which, if it has not actually attained a steady state, is on the way to doing so. By the latter he means the hypothesis that there are two intermingling star-streams, though it is doubtful whether the originators of that hypothesis ever conceived that there were two streams of stars approaching and passing through one another. Our knowledge of stellar motions is derived almost entirely from the nearer stars, and it would be dangerous to make so sweeping an assertion. Reasons are advanced by Prof. Charlier for supposing that the methods of statistical mechanics as developed in (1) can be applied to the monistic conception, and an endeavor is made to show that the state of motion in our system is comparable with the results given by the kinetic theory. The time of relaxation obtained in (1) was thought by Jeans to be too long for our system to be considered as yet in a steady state. Prof. Charlier brings forward evidence to show that the velocities of the stars are in qualitative agreement with the requirements of the kinetic theory [see (2)], and that red stars are more nearly in statistical equilibrium than the younger blue stars. The results obtained in (3) also supported the idea of a steady state. To Eddington's difficulty of believing that the evidence of scattered clusters of stars moving with a common velocity, such as the Ursa Major cluster, can be explained if the chance attractions of stars passing in the vicinity have an appreciable effect on stellar motions, Prof. Charlier replies that it is possible that such clusters are but the remnants of much larger clusters, most of the members of which have succumbed to encounters with other stars by the way. The sparseness of the stars in these clusters may be held to support this view. Furthermore, Jeans has shown that a compact globular cluster moving through another mass of stars will be spread out into a disc-like arrangement, perpendicular to the direction of motion. The conditions of Jeans's discussion cannot be exactly reproduced in the stellar universe, but it is interesting to note that Turner has shown that the Ursa Major system has approximately this shape.

The fifth paper is a valuable discussion of the various methods which have been used for analyzing stellar motions, and forms a convenient summary for purposes of reference. The analysis on the simple hypothesis of a single star-stream, on that of two star-streams developed by Kapteyn and Eddington, on the ellipsoidal hypothesis of Schwarzschild—all of which are based upon the directions of the motions only—and that on the correlation methods developed by Prof. Charlier himself—in which both the magnitude and direction of the motions are taken into account—are discussed and illustrated by application to one particular region of the sky.—H. S. Jones in *Nature*.

Effects of Furnace Conditions on Basic Refractories Used in Smelting Operations

Four series of bricks were made using (1) dolomite, (2) lime, (3) magnesia and (4) magnesite as the chief ingredient, with one of the following bonds: clay, silica, calcium phosphate, ferric oxide, ferrous oxalate, hammer scale (ferrosoferric oxide), ferric phosphate, ferrous phosphate, trimanganic tetroxide, and basic converter slag. The bricks were fired in a commercial oven along with basic bricks at "the highest white heat." The following conclusions were reached. Good bricks may be made without a bond from dolomite, limestone, or magnesia, but not from magnesite as it does not possess sufficient plasticity. By the addition of clay up to 5 per cent, still better bricks may be made and magnesite may then be used. The bricks must be burned for a long time at a "very high white heat." Dolomite and lime bricks produced without a bond, have a durability of about three weeks in dry air; their durability is considerably increased by the addition of clay as bond. Magnesia and magnesite bricks, with or without a clay bond, will last over three months in dry air. A high burning temperature is essential to durability. The dolomite, lime, and magnesite bricks contracted 24 per cent on burning, but those made of strongly calcined magnesia only contracted 4 per cent. Lime and dolomite bricks are strongly attacked by slags and the oxides of iron, much less so by silica, phosphoric acid, and manganese. The foregoing results are strongly in favor of highly calcined magnesia as the best basic material, but the cost of such magnesia bricks is so great that to be profitable their durability in use should be three or four times as great as that of dolomite or lime bricks. According to the author this is not the case. —Note in *Jour. Soc. Chem. Ind.* on an article by A. Wasum in *Trans. Geram. Soc.*

Action of Iodine on Alkalies

When iodine is added to caustic soda, the oxidizing potential, as expressed in hypoiodite, falls off very rapidly, and in a few minutes almost the whole of the iodine is in the state of iodate. Similar reactions take place, though more slowly, with iodine and sodium carbonate, but with sodium bicarbonate neither the formation of iodate nor of hypoiodite is observed. On adding, however, sodium thiosulphate to the mixture, the amount required to decolorize the liquid, and the production of sodium bisulphate, appear to indicate the formation under these conditions of sodium bicarbonate. These mixtures of iodine with caustic soda, sodium carbonate, and bicarbonate, arer ecommended as oxidizing media of variable intensity.—Note in *Jour. Soc. Chem., Ind.*, on an article by J. Bougault in *Comptes Rend.*

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